OVPN SYSTEM, OVPN TERMINATING DEVICE, COLLECTIVE CONTROLLING DEVICE, AND OPTICAL COMMUNICATION NETWORK

BACKGROUND OF THE INVENTION

5   Field of the Invention

Priority is claimed on Japanese Patent Applications No. 2002-355464, filed

December 6, 2002, No. 2002-355437, filed December 6, 2002, No. 2002-355453, filed

December 6, 2002, No. 2002-355397, filed December 6, 2002, No. 2002-355418, filed

December 6, 2002, No. 2002-355379, filed December 6, 2002, No. 2002-355485, filed

10   December 6, 2002, and No. 2002-355498, filed December 6, 2002, the content of which

is incorporated herein by reference.

The present invention relates to a VPN (Virtual Private Network). In particular,

the present invention relates to a VPN which is called a layer 1 VPN or an OVPN in

which various layer signals can be contained.

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Description of Related Art

A VPN is a service in which users may feel as if they are using a private network

while during using a private network. FIG. 1 is a view of a general structure for a

conventional OVPN. According to such a conventional technique, as shown in FIG. 1,

20   the OVPN is commonly formed by connecting optical exclusive lines 123 to 125 which

are leased from a network provider between base points when the user form an OVPN

between the base points. In such a case, the optical exclusive lines 123 to 125 are

formed by optical cross connecting devices (hereinafter called OXCs) 10 to 12. Also,

the OXCs 10 to 12 are formed from OVPN controlling terminals 13 to 15 to the

25   controlling exclusive lines 1 to 6. When OVPN controlling terminals 13 to 15 are

provided to the user, the user can control a part of function in the OXC 10 to 12 which belong to the network provider.

In such OVPN, there is a technique for forming an exclusive line which has a function for transmitting a layer 1 signal transparently such as SDH/SONET, OTN (Optical Transport Network). By transmitting various layer 1 signals (such as PDH, Ethernet (trademark registered), Gigabit Ethernet, Fiberchannel, SDH/SONET, or OTN) via a signal converter which contains the various layer 1 signals in a pass pay load of the SDH/SONET at an entrance of the network or in an optical channel (0 Ch) pay load of the OTN and vial a signal converter which extracts and outputs the layer 1 signals which taken fro the pay load at an exit of the network so as to realize a function for transmitting a digital signal in the layer 1 transparently. However, it is not possible to handle a plurality of layer 1 signals by a signal converter except for a case of Gigabit Ethernet or Fiberchannel.

Therefore, the user of the OVPN must notify the layer 1 signals which the user is going to use to the provider of the OVPN in advance such that the desirable signal converter should by disposed in a terminating device in the OVPN for a case in which the OVPN is formed by the above signal converter. (See Document: "Proposal of Optical VPN service", Misawa, Katayama, Okamoto, Yamanaka, The Society Conference of IEICE, SB-6-4)

Thus, it is possible to provide a function for transport the layer 1 signal transparently in a conventional OVPN. However, there is a problem in that it is difficult to exchange the signal converter and change a connection of the fibers when there is an urgent request that the OVPN user wants to change the contained layer 1 signal.

SUMMARY OF THE INVENTION

The present invention was made in consideration of the above problem. An object of the present invention is to provide an OVPN which can handle the urgent request by the user for changing the signal format which the user uses. Also, other object of the present invention is to provide an OVPN which can execute quick call

5 connection which is requested by the user efficiency so as to improve comfort at the user.

Also, other object of the present invention is to provide an OVPN which can omit an invalid signaling process for the OVPN operation.

Also, other object of the present invention is to provide an OVPN which can improve efficiency for setting up the OVPN by the user.

10 Also, other object of the present invention is to provide an OVPN which can use a transmission path in the OVPN effectively.

Also, other object of the present invention is to provide an OVPN which can transport the signal in the OVPN by a multiplying operation efficiently and set length of the signal to be transported desirably by dividing a long signal.

15 Also, other object of the present invention is to provide an OVPN in which the transmission path can be used effectively.

Also, other object of the present invention is to provide a reliable OVPN which can handle the urgent request by the user for changing the signal format which the user uses.

20 In the present invention, the user of the OVPN registers an IP address which is allocated to the user's own device, a VPNID, and an L1 signal type information which is used in the user's own device in the OVPN terminating device.

Furthermore, in the present invention, when such a registration is performed, the contents of the registration is notified at least to other OVPN terminating device which

25 controls the same VPNID as the user device. By doing this, the contents of the

registration is synchronized between the OVPN terminating devices for controlling at least the same VPNID; thus, it is possible to select the L1 signal type information which can be used commonly in a transmitting user device and in a receiving user device so as to correspond to a calling connection request from the user device quickly. Also, in a

5 case in which there is not an L1 signal type information which can be used commonly in a transmitting user device and in a receiving user device, it is possible to select a device for converting an adequate L1 signal so as to communicate between the transmitting device and the receiving device.

Otherwise, in the present invention, when a calling connection request arrives

10 from the user's device, the contents of the registration is notified to other OVPN terminating device which controls the arriving device. In other OVPN terminating device which receives the notification, it is possible to acknowledge the L1 signal type information which can be used in the transmitting user's device by updating the contents of the user's registration by this notification. By doing this, the OVPN terminating

15 device which receives and acknowledges the L1 signal type information which can be used by the transmitting user's device performs the communication by referring the L1 signal type information which can be used by the arriving user's device so as to notify such a refer to the transmitting user's device.

Otherwise, not only in a case in which only a communication is performed, but

20 also in a case in which an L1 signal type information which is used in the user's device and the L1 signal type information which is used in the OVPN are different each other, it is necessary to convert the signal. Therefore, it is possible to determine the L1 signal type information which is used for the communication. By doing this, it is possible to select the L1 signal type information in which there is a vacancy for the signal converting

25 resource both in the transmitting device and the receiving device so as to avoid a failure

in the communication.

Also, vacancy in the converter depends on a current condition of the resource in the OVPN and a traffic condition. Thus, it is possible to obtain an optimum resource for the L1 signal type information by performing a negotiation between the transmitting device and the receiving device. After the L1 converting resource is obtained, the calling connection is notified; thus, the communication starts.

By doing this, it is possible to correspond to the request for changing the signal format by the user quickly. Also, it is possible to perform the processing the calling connection request efficiently; therefore, it is possible to realize an OVPN which can improve efficiency for the user.

That is, an OVPN system of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN (Optical Virtual Private Network) and a second signal format which is used in the OVPN are different from each other, and an OVPN terminating device for containing the user's device. In this aspect of the present invention, it is characterized in that the OVPN terminating device is provided with a registering section from the user's device for a first signal format type which is used in the user's device together with an IP address of the user's device and a VPNID, a notifying section for notifying contents of the registration to other OVPN terminating device which controls the same VPNID as the user's device, a retrieving section for the first signal format type which corresponds to the IP address and the VPNID in the user's device according to a calling connection request from the user's device by referring to the information which is registered by the registering section, and a selecting section for selecting the first signal format which is

used by the user's device according to a result in the retrieving section when data is transported from the user's device.

An OVPN terminating device according to the present invention for containing a user's device which joins an OVPN has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins the OVPN and a second signal format which is used in the OVPN are different from each other.

Here, in this aspect of the present invention, it is characterized that a registering section from the user's device for a first signal format type which is used in the user's device together with an IP address of the user's device and a VPNID, a notifying section for notifying contents of the registration to other OVPN terminating device which controls the same VPNID as the user's device, a retrieving section for the first signal format type which corresponds to the IP address and the VPNID in the user's device according to a calling connection request from the user's device by referring to the information which is registered by the registering section, and a selecting section for selecting the first signal format which is used by the user's device according to a result in the retrieving section when data is transported from the user's device.

Otherwise, an OVPN system of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN (Optical Virtual Private Network) and a second signal format which is used in the OVPN are different from each other, an OVPN terminating device for containing the user's device, a registering section for registering a first signal format type which is sent

from the user's device so as to be used in the user's device together with an IP address of

the user's device and a VPNID, a notifying section for notifying the registered contents

to other OVPN terminating device which controls a device which receives a calling

connection request when the calling connection request arrives from the user's device, a

5   selecting section for selecting the first signal format which is used in a device which

receives the calling connection request with reference to the registered contents for a

function for corresponding to the other OVPN terminating device, a receiving and

selecting section which receives the first signal format type information which is used in

the device which receives the calling connection request from the other OVPN

10   terminating device so as to respond to a notice from the notifying section and selects the

first signal format type which is used in the user's device according to the format type

information.

Otherwise, an OVPN terminating device of the present invention for containing

a user's device which joins an OVPN has a plurality of converting sections, which are

15   disposed so as to correspond to plural different first signal formats, for converting a first

signal format and a second signal format alternately under conditions in which the first

signal format which is used by a user's device which joins the OVPN and a second signal

format which is used in the OVPN are different from each other, a registering section for

registering a first signal format type which is sent from the user's device so as to be used

20   in the user's device together with an IP address of the user's device and a VPNID, a

notifying section for notifying the registered contents to other OVPN terminating device

which controls a device which receives a calling connection request when the calling

connection request arrives from the user's device, a selecting section for selecting the

first signal format which is used in a device which receives the calling connection request

25   with reference to the registered contents for a function for corresponding to the other

OVPN terminating device, a receiving and selecting section which receives the first signal format type information which is used in the device which receives the calling connection request from the other OVPN terminating device so as to respond to a notice from the notifying section and selects the first signal format type which is used in the

5   user's device according to the format type information.

Otherwise, an OVPN system of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins

10   an OVPN (Optical Virtual Private Network) and a second signal format which is used in the OVPN are different from each other, and an OVPN terminating device for containing the user's device.   In this aspect of the present invention, it is preferable that the OVPN terminating device is provided with a registering section for registering at least a first signal format type which is sent from the user's device so as to be used in the user's

15   device together with an IP address of the user's device and a VPNID, a notifying and selecting section for notifying the registered contents to other OVPN terminating device which controls the device which receives the calling connection request from the user's device when the calling connection request arrives from the user's device and selecting the first signal format type which can be used in the user's device handled between other

20   OVPN terminating device an the user's own device commonly according to the registered contents, a retrieving section a vacancy of the converting section for the alternate converting operation both in the user's own device and other OVPN device when the first signal format type which is selected by the selecting section is different from a second signal format type, and a selecting section which selects at least either one

25   of the converting section for the alternate converting operation which is not occupied for

the user's own device and other OVPN device according to the retrieving result by the

retrieving section.

Otherwise, an OVPN terminating device of the present invention for containing

the user's device has a plurality of converting sections, which are disposed so as to

5 correspond to plural different first signal formats, for converting a first signal format and

a second signal format alternately under conditions in which the first signal format which

is used by a user's device which joins an OVPN and a second signal format which is used

in the OVPN are different from each other, a registering section for registering at least a

first signal format type which is sent from the user's device so as to be used in the user's

10 device together with an IP address of the user's device and a VPNID, a notifying and

selecting section for notifying the registered contents to other OVPN terminating device

which controls the device which receives the calling connection request from the user's

device when the calling connection request arrives from the user's device and selecting

the first signal format type which can be used in the user's device handled between other

15 OVPN terminating device an the user's own device commonly according to the

registered contents, a retrieving section a vacancy of the converting section for the

alternate converting operation both in the user's own device and other OVPN device

when the first signal format type which is selected by the selecting section is different

from a second signal format type, and a selecting section which selects at least either one

20 of the converting section for the alternate converting operation which is not occupied for

the user's own device and other OVPN device according to the retrieving result by the

retrieving section.

Also, it is acceptable if the registering section is provided with a section for

registering a port identifier for the user's own device which corresponds to at least a first

25 signal format which is used in the user's device or an interface identifier together with

the IP address of the user's device and the VPNID. Also, it is preferable that an OVPN terminating device contains the converting section for the alternate converting operation in the user's own device.

A collective converting device of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other, and a section for performing the alternate converting operation which is disposed in the OVPN terminating device commonly.

An optical communication network of the present invention is provided with an OVPN system, an OVPN terminating device, and a collective converting device.

In the present invention, regarding a request concerning which layer 1 signal should be connected to the OVPN, the user of the OVPN determines whether or not it is possible to realize such a request after the OVPN terminating device or the OVPN system acknowledge such a request. Once after it is determined that it is possible to realize such a request, the IP address and the VPNID are added to the user's device. Furthermore, it is characterized that the IP address, the VPNID, and the signal format type information which is used in the user's device are registered.

By doing this, for example, if the layer 1 signal which the user wants to connect to the OVPN cannot be used in the OVPN, it is possible to avoid generating and registering the invalid IP address and the VPNID; thus, it is possible to omit an invalid signaling process for the OVPN operation.

Here, if it is said stated in the present specification that "the layer 1 signal which the user wants to connect to the OVPN cannot be used", it indicates two ways of

condition.   Under one condition, it is a case in which the OVPN is not provided with a

converting function initially.   Under another condition, it is a case in which the OVPN is

provided with a converting function in which other OVPN is occupied.   In the former

case, it can be understood immediately that it is not possible to use.   However, in the

5   latter case, it is possible to await until the resource may be released once after registering

that the OVPN as usable.

Also, it may be acceptable if the user may notify the OVPN terminating device

or the OVPN system of a request regarding which layer 1 signal should be connected to

the OVPN.   It is possible to improve operability for the user by determining the layer 1

10   signal which is used in the user's device which is prepared by the user automatically and

notifying the OVPN terminating device or the OVPN system of the determined result

automatically.   In the present invention, it is possible to determine the layer 1 signal

type automatically which is used in the user's device by disposing a base point device

between the OVPN terminating device in the user's device and the OVPN system.

15   That is, an OVPN system of the present invention has a plurality of converting

sections, which are disposed so as to correspond to plural different first signal formats,

for converting a first signal format and a second signal format alternately under

conditions in which the first signal format which is used by a user's device which joins

an OVPN and a second signal format which is used in the OVPN are different from each

20   other, a retrieving section for detecting whether or not there is a section for performing

the alternate converting operation so as to correspond to the signal format type under

condition the first signal format is different from the second signal format when the first

signal format type information which is used in the user's device is received, a generating

section for generating an IP address and a VPNID to the user's device when there is a

25   section for performing the alternate converting operation as a result of the retrieving

operation by the retrieving section, and a registering section for registering the IP address,

the VPNID generated by the generating section, and the first signal format type

information which is used by the user's device to which the IP address and the VPNID

are added.

5   Otherwise, an OVPN system of the present invention which is disposed in an

OVPN to which a plurality of sub-OVPNs are connected mutually has a plurality of

converting sections, which are disposed so as to correspond to plural different first signal

formats, for converting a first signal format and a second signal format alternately under

conditions in which the first signal format which is used by a neighboring sub-OVPN and

10   a second signal format which is used by the user's own sub-OVPN are different from

each other.

By doing this, in an OVPN structure in which a plurality of sub-OVPNs are

connected to form an OVPN, it is possible to compensate a difference in the signal

format among the sub-OVPNs so as to correspond to various signal format which is used

15   by the user who is connected to each of the sub-OVPN.

An OVPN terminating device of the present invention for containing a user's

device which joins an OVPN is provided with a plurality of converting sections, which

are disposed so as to correspond to plural different first signal formats, for converting a

first signal format and a second signal format alternately under conditions in which the

20   first signal format which is used by a user's device which joins the OVPN and a second

signal format which is used in the OVPN are different from each other.

Here, in this aspect of the present invention, it is characterized in that an OVPN

terminating device is further provided with a retrieving section for detecting whether or

not there is a section for performing the alternate converting operation so as to

25   correspond to the signal format type under condition the first signal format is different

from the second signal format when the first signal format type information which is used in the user's device is received, a generating section for generating an IP address and a VPNID to the user's device when there is a section for performing the alternate converting operation as a result of the retrieving operation by the retrieving section, and a

5 registering section for registering the IP address, the VPNID generated by the generating section, and the first signal format type information which is used by the user's device to which the IP address and the VPNID are added.

Furthermore, it is preferable that an OVPN terminating device should comprise a selecting section for selecting a signal format which is used by the user who receives

10 the calling connection request according to the first signal format type information which is used by the user's device having the IP address, included in the calling connection request, from which the calling connection request is transmitted when the calling connection request is received form the user's device, and a transmitting section for transmitting the format type information which is selected by the selecting section to the

15 user who receives the calling connection request together with the calling connection request.

By doing this, it is possible to designate a signal format which is used in a communication thereafter for the user who receives the format type information. When the user who receives the signal format information uses a signal format except a

20 predetermined signal format and the user who receives the signal format information can select a plurality of signal formats, it is possible to change the signal format according to the notified signal format together with a calling connection request.

Furthermore, in the present invention, it is preferable that an OVPN terminating device further has a notifying section which receives a response to the calling connection

25 request so as to determine whether or not the signal format which is used by the user's

device and the signal format which is employed by the user who receives the calling connection request coincides and notify that the signal formats do not coincide each other for setting up a circuit to the user's device.

That is, in the user's device and the user who receives the signal format
5 information, if the signal format does not coincide, such an information is returned as a response to the calling connection request. In such a case, the user's device does not have a function for receiving the signal format which is used by the user who receives the signal format information. Therefore, it is not possible for the user to acknowledge why it is not possible to set up a network. Thus, the user's device can acknowledge that a
10 failure of setting up a network is caused because the signal format does not coincide by disposing an OVPN terminating device which can correspond to a plurality of signal formats for performing an arbitrating role.

It is preferable that an OVPN terminating device should be provided with a notifying section for notifying a first signal format type information which corresponds
15 to a vacant converting section for performing the alternate converting operation to the user's device when the retrieving result in the retrieving section indicates that there is not a section for performing the alternate converting operation.

By doing this, it is possible to shorten a time for the user to stand-by who wants to communicate by using the vacant network resource effectively.
20 Otherwise, it may be acceptable if an OVPN terminating device may has an inquiring section for inquiring whether or not it is possible to change the vacant converting section for performing the alternate converting operation to other user's device which is under operation when the retrieving result by the retrieving section indicates that that there is not a section for performing the alternate converting operation,
25 and a requesting and generating section for requesting for changing the converting

section for performing the alternate converting operation to other user device when the retrieving result by the retrieving section indicates that there is a section for performing the alternate converting operation and generating the IP address and the VPNID for the user's device.

5   By doing this, it is possible to shorten a time for the user to stand-by who wants to communicate by using the vacant network resource effectively and more positively.

A base point device which is disposed between the OVPN system and the user's device which is contained in the OVPN system or in a OVPN terminating device or between the OVPN system and the OVPN terminating device has a determining section

10   for determining a first signal format type which is used in the user's device, a transmitting section for transmitting the format type information which is determined by the determining section to the OVPN terminating device, and a maintaining section for maintaining the generated IP address and the VPNID.

By doing this, it is possible to realize the present invention with less function in

15   the user's device.   Thus, the user does not need to bear extra cost for realizing a special device for the user.   Therefore, OVPN provides can promote subscriptions for a new user while improving a service quality and operability.

An OVPN system has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal

20   format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other, a retrieving section for detecting whether or not there is a section for performing the alternate converting operation so as to correspond to a plurality of the signal format types under condition the

25   first signal format is different from the second signal format when the first signal format

type information which is used in the user's device is received, a generating section for

generating a plurality of IP addresses which correspond to a plurality of format types and

a VPNID to the user's device when there is a section for performing the alternate

converting operation as a result of the retrieving operation by the retrieving section, and a

5   registering section for registering the VPNID which is added by the generating section, a

plurality of IP addresses, and a plurality of the first signal format type information which

are used by the user's device to which the VPNID and a plurality of the IP addresses are

added, and a section for employing the converting section for performing the alternate

converting operation of the first signal format and the second signal format which

10   correspond to the IP address which is contained in the calling connection request which is

transmitted for a communication flowing the calling connection request by referring to

the registering section when the calling connection request arrives from the user's device.

By doing this, a plurality of IP addresses are added to a user's device such that a

signal format type is determined so as to correspond to the IP addresses.   Therefore, the

15   user does not have to notify the OVPN of the signal format type which the user uses.

Thus, the user can change the signal format simply by changing the IP address.   By

doing this, it is possible to simplify processes for changing the signal format type

frequently.

An OVPN terminating device for containing a user's device which joins an

20   OVPN has a plurality of converting sections, which are disposed so as to correspond to

plural different first signal formats, for converting a first signal format and a second

signal format alternately under conditions in which the first signal format which is used

by a user's device which joins the OVPN and a second signal format which is used in the

OVPN are different from each other.

25   Here, in this aspect of the present invention, it is preferable that an OVPN

terminating device should further comprise a retrieving section for detecting whether or

not there is a section for performing the alternate converting operation so as to

correspond to a plurality of the signal format types under condition the first signal format

is different from the second signal format when the first signal format type information

5   which is used in the user's device is received, a generating section for generating a

plurality of IP addresses which correspond to a plurality of format types and a VPNID to

the user's device when there is a section for performing the alternate converting

operation as a result of the retrieving operation by the retrieving section, and a registering

section for registering the VPNID which is added by the generating section, a plurality of

10   IP addresses, and a plurality of the first signal format type information which are used by

the user's device to which the VPNID and a plurality of the IP addresses are added, and a

section for employing the converting section for performing the alternate converting

operation of the first signal format and the second signal format which correspond to the

IP address which is contained in the calling connection request which is transmitted for a

15   communication flowing the calling connection request by referring to the registering

section when the calling connection request arrives from the user's device.

A base point device which is disposed between the OVPN system and the user's

device which is contained in the OVPN system or in a OVPN terminating device or

between the OVPN terminating device and the user's device which is contained in the

20   OVPN system or in a OVPN terminating device has a determining section for

determining a first signal format type which is used in the user's device, a transmitting

section for transmitting the format type information which is determined by the

determining section to the OVPN terminating device, and a maintaining section for

maintaining the a plurality of generated IP address, the VPNID, and a plurality of the first

25   signal format type information.

By doing this, it is possible to realize the present invention with less function in the user's device. Thus, the user does not need to bear extra cost for realizing a special device for the user. Therefore, OVPN provides can promote subscriptions for a new user while improving a service quality and operability.

5   Also, it is acceptable if an OVPN terminating device should be provided with the converting section for performing the alternate converting operations in the user's own device.

Also, it is acceptable if a base point device is provided with a separating section for separating the user's device and the OVPN, and a returning section for returning a 10   test beam which is transmitted from the OVPN back to the OVPN.

By doing this, OVPN service providers can performs a test when a failure occurs by separating the user's device and the OVPN.

Also, it is acceptable if a collective converting device has a plurality of converting sections, which are disposed so as to correspond to plural different first signal 15   formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other, and a section for performing the alternate converting operation which is disposed in the OVPN terminating device commonly.

20   By doing this, it is not necessary to dispose a converting section for performing the alternate converting operation in the OVPN terminating device; thus, it is possible to simplify a structure in the OVPN terminating device with a reduced cost.

An optical communication network is provided with an OVPN system, an OVPN terminating device, a base point device, and a collective converting device.

25   The present invention is characterized in transmitting plural various layer 1

signal transparently according to a request by the user. In particular, the present invention is characterized in setting up the network by using an IP address thereafter by generating the IP address by the OVPN terminating device when it is detected that the user's device is connected to the OVPN terminating device.

5   After the network is set up, regarding a request for which layer 1 signal should be connected to the OVPN, the user of the OVPN determines whether or not it is possible to realize a request after the OVPN terminating device acknowledges such a request. After it is determined that it is possible to realize such a request, the IP address, the VPNID, and the signal format type information which is used by the user's device are

10   registered.

Also, regarding a request for which layer 1 signal should be connected to the OVPN, the layer 1 signal which is used by the user's device is determined automatically; thus, the determining result is notified to the OVPN terminating device automatically. Thus, it is possible to improve operability for the user.

15   That is, an OVPN system has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other, a detecting section for

20   detecting whether or not the user's device is connected, a generating section for adding the IP address and the VPNID to the user's device according to a control channel when the retrieving result in the detecting section indicates that the user's device is connected, a receiving and determining section for receiving at least a test signal which is transmitted via a data channel by using the IP address from the user's device and

25   determining at least the first signal format type which belongs to the user's device, a

retrieving section for retrieving whether or not there is a converting section for performing the alternate converting operation so as to correspond to the format type according to the determining result by the determining section when the first signal format type which is used by the user's device is different from the second signal format

5 type, and a registering section for registering the IP address which is added by the generating section, the VPNID, and the first signal format type information which is determined by the determining section which is used by the user's device to which the VPNID and the IP address are added when the retrieving result by the retrieving section indicates that there is a converting section for performing the alternate converting

10 operation.

An OVPN terminating device for containing a user's device which joins an OVPN has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used

15 by a user's device which joins the OVPN and a second signal format which is used in the OVPN are different from each other.

Here, in the present aspect of the present invention, it is preferable that an OVPN terminating device should further comprise a detecting section for detecting whether or not the user's device is connected, a generating section for adding the IP

20 address and the VPNID to the user's device according to a control channel when the retrieving result in the detecting section indicates that the user's device is connected, a receiving and determining section for receiving at least a test signal which is transmitted via a data channel by using the IP address from the user's device and determining at least the first signal format type which belongs to the user's device, a retrieving section for

25 retrieving whether or not there is a converting section for performing the alternate

converting operation so as to correspond to the format type according to the determining result by the determining section when the first signal format type which is used by the user's device is different from the second signal format type, and a registering section for registering the IP address which is added by the generating section, the VPNID, and the

5   first signal format type information which is determined by the determining section which is used by the user's device to which the VPNID and the IP address are added when the retrieving result by the retrieving section indicates that there is a converting section for performing the alternate converting operation.

It is preferable that the registering section is provided with a registering section

10   for registering a port identifier or an interface identifier for the user's own device which corresponds to at least a first signal format which is used in the user's device commonly. Also, it is preferable that an OVPN terminating device should be provided with a converting section for performing the alternate converting operation in the user's own device.

15   A base point device of the present invention which is disposed between the OVPN terminating device and the user's device which is contained in the OVPN terminating device has a detecting section for detecting whether or not the user's device is connected to the base point device, a receiving and maintaining section for receiving the IP address and the VPNID which are added to the base point device via the control

20   channel from the OVPN terminating device, and a transmitting section for transmitting the test signal for at least the first signal format which is used by the user's device to the OVPN terminating device via the data channel after the IP address and the VPNID are added to the base point device.

Furthermore, it is preferable that a base point device of the present invention

25   should be provided with a separating section for separating the user's device and the

OVPN, and a returning section for returning a test beam which is transmitted from the OVPN back to the OVPN.

By doing this, OVPN service providers can performs a test when a failure occurs by separating the user's device and the OVPN.

5   A collective converting device of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each

10   other, and a section for performing the alternate converting operation which is disposed in the OVPN terminating device commonly.

By doing this, it is not necessary to dispose a converting section for performing the alternate converting operation in the OVPN terminating device; thus, it is possible to simplify a structure in the OVPN terminating device with a reduced cost.

15   An optical communication network of the present invention is provided with an OVPN system, or an OVPN terminating device, or a base point device, or a collective converting device.

Regarding a request concerning which layer 1 signal should be connected to the OVPN, the present invention is primarily characterized in that a control line is used for

20   notifying the OVPN terminating device or the OVPN system of the request of the user of the OVPN.   By providing the control line for the OVPN user, it is possible for the user to control the OVPN.

Also, the present invention is secondarily characterized in that a data line from the user is connected to plural various signal converters via optical switches.   By

25   disposing the optical switches therebetween, it is possible to contain various layer 1

signals in the OVPN.

Furthermore, the present invention is thirdly characterized in that a control device for controlling the optical switches according to information which is inputted from the control line from the user. By doing this, it is possible to respond to a layer 1 signal type which is changed voluntarily by the user immediately under an end-to-end condition of the OVPN.

Particularly, if the first signal format which is used in the user's device and the second signal format which is used in the OVPN are different from each other, it should be understood that the present invention should be realized under conditions in which a signal which is based on the first signal format is encapsulated by a signal which is based on the second signal format so as to be transmitted in the OVPN.

In such a case, it is characterized in that a signal which is directed to a common destination in the OVPN is multiplied so as to be transmitted. Alternatively, when a signal which is based on the first signal format which is used in the user's device is encapsulated by a signal which is based on the second signal format which is used in the OVPN, if the signal which is based on the first signal format cannot be contained in the signal which is based on the second signal format, it is characterized in that the signal which is based on the first signal format is divided into a plurality of signals so as to be encapsulated by the signal which is based on the second signal format.

By doing this, it is possible to respond to the signal format which is requested to be changed by the user immediately. Also, it is possible to realize an OVPN in which it is possible to use a transmitting path in the OVPN effectively.

An OVPN system of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in

which the first signal format which is used by a user's device which joins an OVPN and a

second signal format which is used in the OVPN are different from each other. In this

aspect of the present invention, it is preferable that the converting section for performing

the alternate converting operation is provided with a transmitting section the first signal

5   format which is transmitted from the user's device to the OVPN by encapsulating the

first signal format by the second signal format, and a transmitting section the

encapsulated signal which is encapsulated by the second signal format which is

transmitted from the OVPN to the user's device by de-encapsulating to the first signal

format, and the transmitting section to the OVPN is provided with a multiplying section

10   for multiplying a plurality of signals by the second signal format which are directed to a

common destination, and the transmitting section to the user's device is provided with a

separating section for the multiplied signal by the multiplying section into a plurality of

signals.

By doing this, the base point which forms the OVPN can form the OVPN

15   flexibly with regardless to the signal format which is employed. Furthermore, a

plurality of signals which are directed to a common destination are united; therefore, it is

possible to use the network resource effectively.

An OVPN terminating device of the present invention for containing a user's

device which joins an OVPN has a plurality of converting sections, which are disposed

20   so as to correspond to plural different first signal formats, for converting a first signal

format and a second signal format alternately under conditions in which the first signal

format which is used by a user's device which joins the OVPN and a second signal

format which is used in the OVPN are different from each other.

Here, in the present aspect of the present invention, it is preferable that an

25   OVPN terminating device should further comprise the converting section for performing

the alternate converting operation in the OVPN terminating device. Also, it is

preferable that the converting section for performing the alternate converting operation is

provided with a transmitting section for transmitting the first signal format which is

transmitted from the user's device to the OVPN by encapsulating the first signal format

5 by the second signal format, and a transmitting section for transmitting the encapsulated

signal which is encapsulated by the second signal format which is transmitted from the

OVPN to the user's device by de-encapsulating to the first signal format, and the

transmitting section to the OVPN is provided with a multiplying section for multiplying a

plurality of signals by the second signal format which are directed to a common

10 destination, and the transmitting section to the user's device is provided with a separating

section for the multiplied signal by the multiplying section into a plurality of signals.

An OVPN system of the present invention has a plurality of converting sections,

which are disposed so as to correspond to plural different first signal formats, for

converting a first signal format and a second signal format alternately under conditions in

15 which the first signal format which is used by a user's device which joins an OVPN and a

second signal format which is used in the OVPN are different from each other. In this

aspect of the present invention, it is preferable that the converting section for performing

the alternate converting operation is provided with a transmitting section for transmitting

the first signal format which is transmitted from the user's device to the OVPN by

20 encapsulating the first signal format by the second signal format, and a transmitting

section for transmitting the encapsulated signal which is encapsulated by the second

signal format which is transmitted from the OVPN to the user's device by

de-encapsulating according to the first signal format, and the transmitting section to the

OVPN is provided with a dividing and encapsulating section for dividing and

25 encapsulating a series of signals according to the first signal format into a plurality of

signals according to the second signal format, and the transmitting section to the user's device is provided with a restoring section for restoring a plurality of signals which are divided by the dividing and encapsulating section into a series of signals.

By doing this, it is possible to encapsulate the signal which is based on the first

5 signal format which is used by the user's device by the signal which is based on the second signal format in the OVPN with regardless to the amount of the data. Therefore, the user can transmit any desirable amount of data which is supposed to be transmitted.

An OVPN terminating device of the present invention for containing a user's device which joins an OVPN has a plurality of converting sections, which are disposed

10 so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins the OVPN and a second signal format which is used in the OVPN are different from each other.

In this aspect of the present invention, it is preferable that the converting section

15 for performing the alternate converting operation is provided with a transmitting section for transmitting the first signal format which is transmitted from the user's device to the OVPN by encapsulating the first signal format by the second signal format, and a transmitting section for transmitting the encapsulated signal which is encapsulated by the second signal format which is transmitted from the OVPN to the user's device by

20 de-encapsulating to the first signal format, and the transmitting section to the OVPN is provided with a dividing and encapsulating section for dividing and encapsulating a series of signals according to the first signal format into a plurality of signals according to the second signal format, and the transmitting section to the user's device is provided with a restoring section for restoring a plurality of signals which are divided by the

25 dividing and encapsulating section into a series of signals.

A collective converting device of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins

5   an OVPN and a second signal format which is used in the OVPN are different from each other, and a section for performing the alternate converting operation which is disposed in the OVPN terminating device commonly.

By doing this, it is not necessary to dispose a converting section for performing the alternate converting operation in the OVPN terminating device; thus, it is possible to

10 simplify a structure in the OVPN terminating device with a reduced cost.

An optical communication network of the present invention is provided with an OVPN system, or an OVPN terminating device, or a collective converting device.

Here, a multi-layer network which is used in the present invention is briefly explained with reference to FIGS. 13 and 14.   FIG. 13 shows a topology for the layer 1

15 network.   FIG. 14 shows a relationship of topologies in a layer 3 network and the layer 1 network.   For example, the layer 3 network is an IP network.   A layer 3 frame is an IP packet.   Also, the layer 1 frame is an Ethernet frame.   A layer 2 network is, for example, an SDH.   Here, detailed explanation is omitted so as to simplify the explanation.   In the topology in the layer 1 network shown in FIG. 13, only a topology

20 which is formed by a node for processing in the layer 1 frame can be observed.   Also, it is ostensibly observed that, in the layer 1 network, the data is transmitted entirely by the layer 1 frame.

However, in the multi-layer network which is employed in the present invention, a layer 3 network exists for a back born network for the layer 1 network as shown in FIG.

25 14.   In the layer 3 network, the data is transmitted by the IP packet in the layer 3 frame.

That is, a signal which reaches from the user's device in a transmitting section to a node in a transmitting section in the layer 1 frame is encapsulated by a signal in the layer 3 frame once in a node in the transmitting section. After that, the encapsulated signal is transmitted in the layer 3 network until reaching at a router in a receiving

5 section.

By doing this, the signal is encapsulated by the layer 3 frames instead of the layer 1 frame intermittently. Such a encapsulating operation is not acknowledged from a layer 1 network point of view. Ostensibly, as shown in FIG. 13, it is observed as if the signal is transmitted from a transmitting user's device throughout the receiving user's

10 device entirely by the layer 1 frame.

In the present invention, it is characterized in that the signal format in the layer 1 which is used in the user's device is encapsulated and de-encapsulated by a signal format in an upper layer than the layer 1 which is employed in the OVPN. Originally, OVPN is a service in which an L1 transparent exclusive network is virtually produced; therefore, it

15 is actually acceptable to produce a layer 2 or a layer 3 network as long as it looks an L1 transparent exclusive network to a user. For example, a layer 3 is an IP network. In such a case, it is possible to transmit a plurality of IP packets from a transmitting router under a multiplied condition so as to allocate destinations according to IP header which is observed by a receiving router as long as it is performed in the IP network. By doing

20 this, it is possible to enhance a transmission efficiency in the OVPN. Also, it is possible to transmit a series of signals by a plurality of frames by dividing the series of signals in a case if the series of signals it too long to be contained in a frame.

By doing this, it is possible to handle the urgent request by the user for changing the signal format which the user uses. Also, it is possible to multiply the signal which is

25 transmitted in the OVPN efficiently. Thus, it is possible to realize in which it is

possible to set the length of the signal by transmitting long signals under a divided

condition.

That is, an OVPN system of the present invention has a plurality of converting

sections, which are disposed so as to correspond to plural different first signal formats,

5   for converting a first signal format in a layer 1 which is employed in a user's device

which joins an OVPN and a second signal format which is prior to the layer 1 which is

employed in the OVPN alternately. In this aspect of the present invention, it is preferable

that the converting section for performing the alternate converting operation is provided

with a transmitting section for transmitting the first signal format which is transmitted

10   from the user's device to the OVPN by encapsulating the first signal format by the

second signal format, and a transmitting section for transmitting the encapsulated signal

which is encapsulated by the second signal format which is transmitted from the OVPN

to the user's device by de-encapsulating according to the first signal format.

In the OVPN system of the present invention, it is preferable that the

15   transmitting section to the OVPN is provided with a multiplying section for multiplying a

plurality of signals according to the second signal format.   Alternatively, in an OVPN

system of the present invention, it is preferable that the transmitting section to the OVPN

is provided with a dividing and encapsulating section for dividing and encapsulating a

series of signals according to the first signal format into a plurality of signals according

20   to the second signal format.

By doing this, the base point which forms the OVPN can form the OVPN

flexibly with regardless to the signal format which is employed.   Furthermore, in the

present invention, the signals are multiplied or divided; it is possible to transmit the

signals efficiently.

25   An OVPN terminating device of the present invention for containing a user's

device which joins an OVPN has a plurality of converting sections, which are disposed

so as to correspond to plural different first signal formats, for converting a first signal

format and a second signal format alternately under conditions in which the first signal

format which is used by a user's device which joins the OVPN and a second signal

5   format which is used in the OVPN are different from each other.

In this aspect of the present invention, it is preferable that an OVPN terminating

device further has the converting section for performing the alternate converting

operation in the OVPN terminating device.   Also, it is preferable that the converting

section for performing the alternate converting operation is provided with a transmitting

10   section for transmitting the first signal format which is transmitted from the user's device

to the OVPN by encapsulating the first signal format by the second signal format, and a

transmitting section for transmitting the encapsulated signal which is encapsulated by the

second signal format which is transmitted from the OVPN to the user's device by

de-encapsulating to the first signal format.

15   It is preferable that, in the OVPN terminating device, the transmitting section to

the OVPN is provided with a multiplying section for multiplying a plurality of signals

according to the second signal format.   Also, it is preferable that the transmitting section

to the OVPN is provided with a dividing and encapsulating section for dividing and

encapsulating a series of signals according to the first signal format into a plurality of

20   signals according to the second signal format.

A collective converting device of the present invention has a plurality of

converting sections, which are disposed so as to correspond to plural different first signal

formats, for converting a first signal format in a layer 1 which is employed in a user's

device which joins an OVPN and a second signal format which is prior to the layer 1

25   which is employed in the OVPN alternately, and the converting section for performing

the alternate converting operation for the OVPN terminating device commonly.

By doing this, it is not necessary to dispose a converting section for performing the alternate converting operation in the OVPN terminating device; it is possible to simplify the structure in the OVPN terminating device and reduce a product cost for the

5 OVPN terminating device.

An optical communication network is provided with an OVPN system, or an OVPN terminating device, or a collective converting device.

The present invention is characterized in transmit plural various layer 1 signals transparently according to a request by the user. In particular, the base point device is

10 disposed between the user's device and the OVPN terminating device such that the IP address is generated by the OVPN terminating device for the base point device when the base point device is connected to the user's device. By doing this, it is characterized in that the base point device performs the setting up operation thereafter automatically by using the IP address.

15 In the OVPN, a control line and a data line are necessary respectively. The control line and the data line must be connected and disconnected when the user's device and the OVPN terminating device are connected and released. In the present invention, the base point device and the OVPN terminating device are connected by the control line and the data line in advance such that the base point device and the OVPN terminating

20 device are connected and released by connecting and releasing the control line and the data line in advance. Thus, it is possible to simplify the setting in the user's device. For example, regarding connecting the user's device and the base point device, the user can connect the user's device and the base point device by a cable by multiplying the control channel and the data channel.

25 Once after the setting up operation was completed and the OVPN terminating

device acknowledged a request regarding which layer 1 signal to be connected to the OVPN, it is determined whether or not it is possible to realize such a request. If it is determined that it is possible, the IP address, the VPNID, and the signal format type information which is employed in the user's device are registered.

,5   Also, it may be acceptable if the user notify the OVPN terminating device of the request regarding which layer 1 signal to be connected to the OVPN. Therefore, it is possible to improve operability for the user by determining the layer 1 signal which is employed in the user's device automatically and notifying the OVPN of the determining result automatically.

10   By doing this, it is possible to handle the urgent request by the user for changing the signal format which the user uses. Also, it is possible to perform a connection process for the user's device to the OVPN efficiently; thus, it is possible to improve operability for the user.

An OVPN system of the present invention has a plurality of converting sections,

15   which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other, and a receiving and transmitting section for receiving a notice that the user's device is

20   connected to the base point device via the control channel from the base point device which is disposed between the user's device and the OVPN and transmitting the IP address and the VPNID which are allocated to the user's device according to the base point device.

An OVPN terminating device of the present invention for containing a user's

25   device which joins an OVPN has a plurality of converting sections, which are disposed

so as to correspond to plural different first signal formats, for converting a first signal

format and a second signal format alternately under conditions in which the first signal

format which is used by a user's device which joins the OVPN and a second signal

format which is used in the OVPN are different from each other.

5   In this aspect of the present invention, it is preferable that the OVPN terminating

device further has a receiving and transmitting section for receiving a notice that the

user's device is connected to the base point device via the control channel from the base

point device which is disposed between the user's device and the OVPN and transmitting

the IP address and the VPNID which are allocated to the user's device according to the

10 base point device.

   An OVPN terminating device of the present invention has a receiving section for

receiving a receipt confirmation which is transmitted from a transmitting section for the

IP address and the VPNID for the IP address and the VPNID, and a transmitting section

for transmitting a final connection confirmation for notifying the receipt of the receipt

15 confirmation by the receiving section to the base point device.

   That is, it is not limited to a case in which only one OVPN terminating device

receives the notice. There is a case in which a plurality of the OVPN terminating

devices receive the notice. Accordingly, there is a case in which a plurality of IP

addresses and a plurality of VPNIDs are transmitted to the base point device. The base

20 point device selects either one of a plurality of IP addresses and a plurality of VPNIDs

and transmits a receipt confirmation back to the address from which the IP address and

the VPNID are transmitted. The OVPN which receives the receipt confirmation starts

preparing for setting up the network by transmitting a final connection confirmation to

the base point device. For example, an OVPN terminating device which is the closest

25 to the base point device is selected. More specifically, an OVPN terminating device is

selected at which the IP address and the VPNID arrives the soonest.

An OVPN terminating device of the present invention has a receiving and retrieving section for receiving the first signal format type information which is employed by the user's device according to the control channel after the final connection

5   confirmation is transmitted so as to retrieving whether or not there is a converting section for performing the alternate converting operation so as to correspond to the format type, and a registering section for registering the IP address and the VPNID which are allocated to the user's device, and the first signal format type information which is employed by the user's device when the retrieving result in the receiving and registering

10 section indicates that there is a converting section for performing the alternate converting operation.   Also, an OVPN terminating device is provided with the converting section for performing the alternate converting operation in the OVPN terminating device.

A base point device of the present invention which is disposed between the OVPN terminating device and a user's device which is contained in the OVPN

15 terminating device has a detecting section for detecting whether or not the user's device is connected to the base point device, a notifying section for notifying at least one of the OVPN terminating device via the control channel that it is detected that the user's device is connected to the base point device, a receiving section for receiving the IP address and the VPNID which are allocated to the user's device from the OVPN terminating device

20 via the control channel, a transmitting section for transmitting a receipt confirmation that the receiving section received the IP address and the VPNID to the OVPN terminating device, and a transmitting section the first signal format type information which is used by the user's device, the IP address, and the VPNID to the OVPN terminating device which received the final connection receipt for the receipt confirmation via the control

25 channel.

Also, a base point device of the present invention has a determining section for determining the first signal format type information which is employed in the user's device, and a transmitting device for transmitting the format type information which is determined by the determining section to the OVPN terminating device.

5　　　　　Furthermore, a base point device of the present invention has a separating section for separating the user's device and the OVPN, and a returning section for returning a test beam which is emitted from the OVPN back to the OVPN.

By doing this, OVPN service providers can perform a test when a failure occurs by separating the user's device and the OVPN.

10　　　　　A collective converting device of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins the OVPN and a second signal format which is used in the OVPN are different from each other, and a converting section for the alternate converting operation for the OVPN

15　terminating device commonly.

By doing this, it is not necessary to dispose a converting section for performing the alternate converting operation in the OVPN terminating device; thus, it is possible to simplify a structure in the OVPN terminating device with a reduced cost.

20　　　　　An optical communication network of the present invention is provided with an OVPN system, or an OVPN terminating device, or a base point device, or a collective converting device.

In the present invention, an OVPN system uses an OVPN terminating device which can convert plural various signals so as to correspond to a plurality of L1 signal

25　types which are used by the user of the OVPN.　　In such an OVPN system, it is

characterized that a multiplied wavelength method is used for transmitting a signal to the

user and the OVPN so as to use a transmission path efficiently. Furthermore, it is

characterized in that information for the wavelength for each user's device and

information that these wavelengths are multiplied are notified to the OVPN. By doing

5   this, it is characterized in that the notified information is utilized; thus, it is possible to

separate the wavelength efficiently in the OVPN.

A base point device of the present invention which is disposed between an

OVPN and a user's device has a plurality of converting sections, which are disposed so

as to correspond to plural different first signal formats, for converting a first signal

10   format and a second signal format alternately under conditions in which the first signal

format which is used by a user's device which joins the OVPN and a second signal

format which is used in the OVPN are different from each other.

In this aspect of the present invention, it is preferable that the base point device

further has a multiplying and transmitting section for multiplying and transmitting a

15   plurality of optical wavelength signals which are used in the user's device to the OVPN,

a separating and transmitting section for separating and transmitting the multiplied

optical wavelength signals which arrive from the OVPN, and a notifying section for

notifying the OVPN of information for the wavelength which are transmitted under a

multiplied condition so as to be used in a plurality of the user's devices.

20   An OVPN terminating device of the present invention for containing the user's

device via the base point device has a multiplying and transmitting section for

multiplying and transmitting a plurality of optical wavelength signals which are used in

the user's device to the OVPN, and a separating and transmitting section for separating

and transmitting the multiplied optical wavelength signals which arrive from the base

25   point device so as to transmit to a predetermined course according to information which

is notified from the notifying section.

Also, the present invention is characterized in that a series of serial signals are converted into a plurality of parallel signals and transmitted; thus, it is possible to compensate a difference of transmitting speed of the signal between the user and the

5   OVPN. In such a case, information that the serial signals are converted into the parallel signals, and information of topology for the parallel signals are notified to the OVPN. By doing this, a plurality of parallel signals which were originally a series of serial signals can be transmitted as a group. When, for example, a plurality of parallel signals are transmitted parallel by using a plurality of transmitting paths having different

10   transmitting distances, there occurs a time difference at which the signals arrive at the destinations. In such a case, it is possible to reduce such a time difference at which the signals arrive at the destinations by transmitting the signals by using a plurality of transmitting paths of which transmitting distances are similar.

A base point device of the present invention has which is disposed between an

15   OVPN and a user's device has a converting and transmitting section for converting a serial signal which is transmitted from the user's device into a plurality of parallel signals so as to transmit to the OVPN, a converting and transmitting section for converting a plurality of the parallel signals which arrive from the OVPN into a serial signal so as to transmit to the user's device, and a notifying section for notifying the OVPN of

20   information for the topology of the parallel signals and information that the serial signals are converted to the parallel signals.

An OVPN terminating device of the present invention for containing the user's device via the base point device has an inputting section for inputting the parallel signals which are divided from a series of serial signals in to a plurality of the converting section

25   for performing the alternate converting operation so as to correspond to the first signal

format type information according to the information which is notified from the notifying section in the base point device.

Also, in the present invention, it is possible to perform a wavelength-multiplying operation to the parallel signals so as to transmit. By doing this, it is possible to use the transmitting paths more efficiently.

Alternately, a base point device of the present invention has a multiplying and transmitting section for multiplying the parallel signal which is converted from the serial signal which is transmitted from the user's device so as to transmit to the OVPN, a separating and transmitting section for separating the multiplied wavelength signals which arrive from the OVPN into the parallel signals and converting the parallel signals into the serial signals so as to transmit to the user's device, and a notifying section for notifying the OVPN of the information that the serial signals are converted to the parallel signals, the information for a topology of the parallel signals, and the information that the parallel signals are transmitted under wavelength-multiplied condition.

Alternately, an OVPN terminating device of the present invention for containing the user's device via the base point device has a multiplying and transmitting section for multiplying the parallel signals which arrive from the OVPN as to transmit to the base point device, a separating and transmitting section for separating the multiplied optical wavelength signals which arrive from the base point device so as to transmit to the OVPN as the parallel signals, and an inputting section for inputting the parallel signals which are divided from a the multiplied wavelength signals into a plurality of the converting section for performing the alternate converting operation so as to correspond to the first signal format type information according to the information which is notified from the notifying section in the base point device.

Also, an OVPN system of the present invention has a plurality of converting

sections, which are disposed so as to correspond to plural different first signal formats,
for converting a first signal format and a second signal format alternately under
conditions in which the first signal format which is used by a user's device which joins
an OVPN and a second signal format which is used in the OVPN are different from each

5   other. In this aspect of the present invention, it is preferable that at least a part of the
converting sections for performing the alternate converting operation are provided with
converting sections for converting a series of serial signals according to the first signal
format which are transmitted from the user's device into a plurality of parallel signals in
the OVPN according to the second signal format and converting a plurality of the parallel

10   signals according to the second signal format directed to the user's device from the
OVPN into a series of serial signals according to the first signal format alternately.

An OVPN terminating device of the present invention for containing the user's
device which joins the OVPN has a plurality of converting sections, which are disposed
so as to correspond to plural different first signal formats, for converting a first signal

15   format and a second signal format alternately under conditions in which the first signal
format which is used by a user's device which joins the OVPN and a second signal
format which is used in the OVPN are different from each other, a converting section for
performing the alternate converting operation in the OVPN terminating device. In this
aspect of the present invention, it is preferable that at least a part of the converting

20   sections for performing the alternate converting operation include converting sections for
converting a series of serial signals according to the first signal format which are directed
to the OVPN from the user's device into a plurality of parallel signals in the OVPN
according to the second signal format and converting a plurality of the parallel signals
according to the second signal format directed to the user's device from the OVPN into a

25   series of serial signals according to the first signal format alternately.

By doing this, it is possible to adjust the transmitting speed for the signals in a case in which the transmitting speed in the OVPN is slower than the transmitting speed outside the OVPN.

An OVPN terminating device of the present invention is provided with the converting section for performing the alternate converting operation in the OVPN terminating device. Also, a base point device of the present invention is provided with a separating section for separating the user's device and the OVPN, and a returning section for returning a test beam which is transmitted from the OVPN back to the OVPN.

By doing this, OVPN service providers can performs a test when a failure occurs by separating the user's device and the OVPN.

A collective converting device of the present invention has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other, and a section for performing the alternate converting operation which is disposed in the OVPN terminating device commonly.

By doing this, it is not necessary to dispose a converting section for performing the alternate converting operation in the OVPN terminating device; thus, it is possible to simplify a structure in the OVPN terminating device with a reduced cost.

An optical communication network of the present invention is provided with a base point device, or an OVPN terminating device, or a collective converting device.

In the present invention, an OVPN system uses an OVPN terminating device which can convert plural various signals so as to correspond to a plurality of L1 signal types which are used by the user of the OVPN. In such an OVPN system, it is

characterized that a base point device is disposed at the user so as to contain the user's device such that the base point device relays the control channel and the data channel between the user's device and the OVPN terminating device. Also, as a first feature, the base point device monitors a failure in the control channel and the data channel so as

,5   to maintain the communication by using a control channel and a data channel in which a failure does not occur by a cooperative reaction with other base point devices when a failure occurs. By doing this, it is possible to handle a failure in the control channel and the data channel which is caused due to the base point device.

Also, as a second feature, the base point device maintains the communication by

10   using a control channel and a data channel in which a failure does not occur by a cooperative reaction with other base point devices when a failure occurs due to the OVPN terminating device.

A base point device of the present invention which is disposed between an OVPN system and a user's device has a plurality of converting sections, which are

15   disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal format which is used by a user's device which joins an OVPN and a second signal format which is used in the OVPN are different from each other.

Here, in this aspect of the present invention, it is preferable that the base point

20   device further has a recording section for recording a group for the base point device which relates to a common VPNID, a detecting section for detecting an occurrence of a failure in a control channel and a data channel, a requesting section for requesting that other base point device in a same group should perform processes which is supposed to be performed by the detecting section which has a failure with reference to the recording

25   section.

Furthermore, a base point device of the present invention has a recording section for recording a group for the OVPN terminating device which relates to a common VPNID, a detecting section for detecting an occurrence of a failure in a control channel and a data channel, a requesting section for requesting that other OVPN terminating

5 device in a same group should perform processes which is supposed to be performed by the OVPN terminating device which has a failure in the control channel with reference to the recording section when the detecting section detects the occurrence of the failure.

Furthermore, a base point device of the present invention is provided with a separating section for separating the user's device and the OVPN, and a returning section

10 for returning a test beam which is transmitted from the OVPN back to the OVPN.

An OVPN terminating device of the present invention for containing a user's device which joins an OVPN has a plurality of converting sections, which are disposed so as to correspond to plural different first signal formats, for converting a first signal format and a second signal format alternately under conditions in which the first signal

15 format which is used by a user's device which joins the OVPN and a second signal format which is used in the OVPN are different from each other.

Here, In this aspect of the present invention, it is preferable that the OVPN terminating device further has a recording section for recording a group for the OVPN terminating device which relates to a common VPNID, a detecting section for detecting

20 an occurrence of a failure in a control channel and a data channel, a requesting section for requesting that other OVPN terminating device in a same group should perform processes which is supposed to be performed by the OVPN terminating device which has a failure in the control channel with reference to the recording section when the detecting section detects the occurrence of the failure.

25 An optical communication network of the present invention is provided with a

base point device, or the OVPN terminating device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a structure for a conventional OVPN.

FIG. 2 shows an OVPN for a 6th embodiment and a 13th embodiment of the present invention.

FIG. 3 shows a concept for operations in the OVPN in a first embodiment of the present invention.

FIG. 4 is a view for explaining contents which is registered in a database in the first embodiment.

FIG. 5 shows a concept for operations in the OVPN in the first embodiment of the present invention.

FIG. 6 shows a concept for operations in the OVPN in a second embodiment of the present invention.

FIG. 7 shows a sequence diagram for operations in the OVPN in the second embodiment of the present invention.

FIG. 8 shows a sequence diagram for operations in the OVPN in a third embodiment of the present invention.

FIG. 9 is a view for explaining a separating test performed in a fourth embodiment.

FIG. 10 is a view for an example for a structure of a collective converting device according to a fifth embodiment.

FIG. 11 is a sequence diagram for setting up a network according to a sixth embodiment.

FIG. 12 is a block diagram for an optical switch controlling device according to

sixth embodiment.

FIG. 13 is a sequence diagram for setting up a network according to a sixth embodiment.

FIG. 14 is a sequence diagram for setting up a network according to a seventh embodiment.

FIG. 15 is a sequence diagram for setting up a network according to an eighth embodiment.

FIG. 16 is a view for explaining a structure in an OVPN according to a ninth embodiment.

FIG. 17 is a view for explaining a base point device according to the ninth embodiment.

FIG. 18 is a sequence diagram for setting up a network according to a tenth embodiment.

FIG. 19 is a view for explaining a base point device according to an eleventh embodiment.

FIG. 20 is a view for explaining a structure in an OVPN according to a twelfth embodiment.

FIG. 21 is a block diagram for an optical switch controlling device according to a thirteenth embodiment.

FIG. 22 is a block diagram for a signal determining section according to the thirteenth embodiment.

FIG. 23 is a database registering pattern according to the thirteenth embodiment.

FIG. 24 is a flow chart for showing operations in an OVPN terminating device according to the thirteenth embodiment.

FIG. 25 shows the OVPN for a fourteenth embodiment.

FIG. 26 is a block diagram for a base point device according to the fourteenth embodiment.

FIG. 27 is a view for explaining a testing procedure according to a fifteenth embodiment.

5   FIG. 28 is a view for explaining a collective converting device according to a sixteenth embodiment.

FIG. 29 is a view for explaining a structure of an OVPN according to a seventeenth embodiment and a twenty-third embodiment.

FIG. 30 is a view for explaining an OVPN terminating device according to the

10   seventeenth embodiment.

FIG. 31 is a view for explaining a encapsulating condition and a de-encapsulating condition according to the seventeenth embodiment.

FIG. 32 is a view for explaining a structure for an OVPN according to an eighteenth embodiment and a nineteenth embodiment.

15   FIG. 33 is a view for explaining an OVPN terminating device according to the eighteenth embodiment and the nineteenth embodiment.

FIG. 34 is a view for explaining a encapsulating condition and a de-encapsulating condition according to the eighteenth embodiment.

FIG. 35 is a view for explaining a encapsulating condition and a

20   de-encapsulating condition according to the nineteenth embodiment.

FIG. 36 is a view for explaining an OVPN terminating device according to a twentieth embodiment and a twenty-ninth embodiment.

FIG. 37 is a view for explaining an OVPN terminating device according to the twentieth embodiment.

25   FIG. 38 is a view for explaining a structure for an OVPN according to an

twenty-first embodiment.

FIG. 39 is a view for explaining a structure for an OVPN according to an twenty-first embodiment.

FIG. 40 is a view for explaining a structure for an OVPN according to an

5   twenty-first embodiment.

FIG. 41 is a view for explaining a multiplying operation for a frame according to a twenty-second embodiment.

FIG. 42 is a view for explaining a dividing operation for frame according to a twenty-third embodiment.

10   FIG. 43 is a view for explaining an IP encapsulating operation and an IP de-encapsulating operation for an Etherframe and an SDH frame.

FIG. 44 is a view for explaining an MPLS encapsulating operation and an MPLS de-encapsulating operation for an Etherframe and an SDH frame.

FIG. 45 is a view for explaining an OVPN terminating device according to the

15   twenty-third embodiment.

FIG. 46 is a view for explaining a structure for an OVPN according to a twenty-fourth embodiment.

FIG. 47 is a view for explaining an IP encapsulating operation by dividing an SDH frame into a plurality of frames.

20   FIG. 48 is a view for explaining an MPLS encapsulating operation by dividing an SDH frame into a plurality of frames.

FIG. 49 is a view for explaining an OVPN terminating device according to the twenty-fourth embodiment.

FIG. 50 is a view for showing a topology for a layer 1 network.

25   FIG. 51 is a view for explaining a relationship of a topology between the layer 3

network and the layer 1 network.

FIG. 52 is a view for explaining a structure for an OVPN according to a twenty-fifth embodiment.

FIG. 53 is a block diagram for a base point device according to the twenty-fifth embodiment.

FIG. 54 is a block diagram for an optical switch controlling device according to the twenty-fifth embodiment.

FIG. 55 is a sequence diagram for operations according to the twenty-fifth embodiment.

FIG. 56 is a view for explaining an L1 signal determining operation according to the twenty-fifth embodiment.

FIG. 57 is a block diagram for a separating testing apparatus according to the twenty-fifth embodiment.

FIG. 58 is a block diagram for a collective converting device according to the twenty-fifth embodiment.

FIG. 59 is a view for explaining a structure for an OVPN according to a twenty-sixth embodiment.

FIG. 60 is a block diagram for a base point device and an OVPN terminating device according to a twenty-seventh embodiment.

FIG. 61 is a block diagram for a base point device and an OVPN terminating device according to a twenty-eighth embodiment.

FIG. 62 is a view for explaining a testing method for a circuit which is disposed in the base point device according to a twenty-ninth embodiment.

FIG. 63 is a block diagram for an OVPN terminating device according to a thirtieth embodiment.

FIG. 64 is a view for a structure for an OVPN according to a thirty-first embodiment.

FIG. 65 is a block diagram for a base point device according to the thirty-first embodiment.

5   FIG. 66 is a flow chart for explaining operations in the base point device according to the thirty-first embodiment.

FIG. 67 is a view for a structure for an OVPN according to a thirty-second embodiment.

FIG. 68 is a flow chart for explaining operations in the base point device
10   according to the thirty-second embodiment.

FIG. 69 is a block diagram for an important part of an OVPN terminating device according to a thirty-third embodiment.

FIG. 70 is a view for explaining a separating testing method in the base point device according to a thirty-fourth embodiment.

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DETAILED DESCRIPTION OF THE INVENTION

First Embodiment

A first embodiment is explained with reference to FIGS. 2 to 5. FIG. 2 is a view for showing a structure for an OVPN which has a basic structure for the present
20   embodiment. FIG. 3 is a view for showing a concept for operations in the first embodiment. FIG. 4 is a view for explaining contents in a database according to the first embodiment. FIG. 5 is a view for showing a concept of operations according to the first embodiment. In order to simplify the explanation, in FIG. 1, a case is shown in which a signal is transmitted from user's devices 20-1, 21-1 which are located in an
25   upper-left part in the drawing to user's device 20-2 which is located in a lower-left part in

the drawing.   In an ordinary communication, a signal is transmitted in a reverse

direction simultaneously.   Also, OVPN terminating devices 30 and 80 are the same

devices as each other shown in FIG. 2.   Also, network controlling devices 40 and 60 are

the same devices as each other.   Optical cross connecting devices 50 and 70 are the

5   same devices as each other.   Hereinafter, in order to simplify the explanation,

explanations are made mainly for the OVPN terminating device 30, the network

controlling device 40, and the optical cross connecting device 50.   Thus, explanations

for the OVPN terminating device 80, the network controlling device 60, and the optical

cross connecting device 50 are omitted.   Here, in the present embodiment, explanations

10   are made for an SDH.   More importantly, such explanations for the SDH can be applied

to a case for a SONET.

A direction for the optical cross connecting device 50 is set by the network

controlling device 40; thus, an OVPN is formed such that an SDH network is disposed

among the base points.

15   In the first embodiment, the OVPN terminating device 30 is provided with

converters 33 and 34 for converting a Gibabit Ethernet or an ATM as a first signal format

which is employed in the user's devices 20-1, 20-2, and 21-1 and an SDH as a second

signal format which is different from the first signal format which is employed in the

OVPN mutually.   A plurality of converters 33 and 34 are disposed so as to correspond to

20   a plurality of different first signal formats.   The optical switch 32 is controlled so as to

determine which converters 33 or 34 to be used.

Here, if a signal format in the user's device and a signal format in the OVPN are

the same as each other, it is not necessary to convert the signals; thus, it is possible to

perform a communication without transmitting via the converters 33 and 34.   Such a

25   case is not explained in the present invention because it is not necessary to explain a

technical feature of the present invention.

Also, even if a signal format in the user's device 20-1 and a signal format in the user's device 20-2 are different from each other, it is possible to use the OVPN if the signals can be converted. Here, in order to simplify the explanation, a case is explained

5　in which the signal format is the same as each other.

That is, the OVPN terminating device 30 in the first embodiment is characterized to be provided with an optical switch controlling device 31 which contains a user's device 20-1 so as to register the first signal format type from the user's device which is used in the user's device 20-1 together with the IP address and the VPNID of the

10　user's device and notify the contents of the registration to other OVPN terminating device 80 which manages the VPNID which is at least the same as that in the user's device 20-1. Also, the optical switch controlling device 31 retrieves the first signal format type which corresponds to the IP address and the VPNID of the user's device according to a call connecting request from the user's device 20-1 with reference to the

15　registered information so as to select the first signal format which is used in the user's device 20-1 according to the retrieved result when data is transmitted from the user's device 20-1. .

Next, operations in the present embodiment is explained with reference to FIGS. 3 to 5. Here, a database which is shown in FIGS. 3 to 5 is provided in the optical switch

20　controlling devices 31 and 81 shown in FIG. 2.

According to a concept view shown in FIG. 3, VPNID is indicated by an "a" and "b". Also, the OVPN terminating devices 30-1, 30-2, 80-1, and 30-3 are provided in different groups in different VPNIDs.

In the first embodiment, when the user's device 20-11 registers a L1 signal type

25　information which is used by the user's device 20-11 together with the IP address and the

VPNID of the user's device 20-11 in the OVPN terminating device 30-1, the OVPN terminating device 30-1 notifies the registered contents to the other OVPN terminating devices 30-1 and 80-1 which belong to the same VPNID.

By doing this, the contents in the database in the OVPN terminating devices 30-1, 30-2, and 80-1 which have the same VPNID are synchronized. Also, a port identifier of the device which corresponds to at least a first signal format which is used in the user's device or an interface identifier is registered together with the IP address and the VPNID of the user's device in the database as shown in FIG. 3.

By doing this, when the OVPN terminating device receives a calling connection request from the user's device, the OVPN terminating device retrieves in the database such that the usable L1 signal type can be selected quickly. Also, the port identifier and the interface identifier are registered together with the IP address and the VPNID of the user's device; thus, it is possible to switch a direction in the optical switch 32.

Also, as shown in FIG. 5, if the OVPN terminating device 30-1 notifies an NMS (Network Management System) which is provided in the OVPN terminating device 30-1 of the contents in the database, the NMS can notify to the other OVPN terminating devices 80-1 and 30-2 which have the same VPNID.

A second embodiment is explained with reference to FIGS. 6 and 7. FIG. 6 is a general view for explaining operations in the second embodiment. FIG. 7 is a sequence diagram for operations in the second embodiment.

In the second embodiment, as shown in FIG. 6, the OVPN terminating device 30 notifies the other OVPN terminating device 80 which controls devices to which a calling connection is sent of the registered contents when the calling connection request arrives from the user's device 20-1. Also, the OVPN terminating device 30 has a function for selecting the first signal format which is used by the device which receives the calling

connection request with reference to the registered contents which corresponds to the OVPN terminating device 80.

By doing this, the OVPN terminating device 30 receives the first signal forma type information which is used in the device which receives the calling connection

5 request from the other OVPN terminating device 80 so as to respond to the notification and selects the first signal format type which is used by the user's device 20-1 based on the signal type information.

That is, as shown in FIG. 7, when a calling connection request arrives at the OVPN terminating device 30 from the user's device 20-1, the OVPN terminating device

10 30 transmits the registered contents pertaining to the user's device 20-1 to the other OVPN terminating device 80 which receives the calling connection request. The OVPN terminating device 80 updates the database therein according to the transmitted registered contents. The OVPN terminating device 80 selects the L1 signal type which is used for a communication with the user's device 20-1 which transmits the calling

15 connection request with reference to the updated database. A notification of the calling connection based on the selected L1 signal type is transmitted to the OVPN terminating device 30 which transmits the calling connection request. When the OVPN terminating device 30 which transmits the calling connection request receives the notification of the calling connection request, the OVPN terminating device 30 transfers the notification of

20 the calling connection to the user's device 20-1 which transmits the calling connection request. By doing this, a communication network is set up between the user's device 20-1 which transmits the calling connection request and the device 20-1 which receives the calling connection request

Third Embodiment

25 A third embodiment is explained with reference to FIG. 8. FIG. 8 is a sequence

diagram for operations in the third embodiment. The OVPN terminating device of the third embodiment notifies the registered contents to the other OVPN terminating device which manages the device which receives the calling connection request of the user's device when the calling connection requests arrives from the user's device. The OVPN

5 terminating device selects the first signal format type which can be used the user's device which can correspond commonly between the other OVPN terminating device and the OVPN terminating device which notifies the registered contents. When the selected first signal format type is different from the second signal format type, these OVPN terminating devices retrieve the vacancy of the converter. The OVPN terminating

10 devices select at least either one of converter which is not vacant commonly according to the retrieved result.

By doing this, the condition of the vacancy in the converter depends on the current usage condition of the resource in the OVPN or the current traffic condition. In such a case, both the device which transmits the calling connection request and the

15 device which receives the calling connection request negotiate each other; thus, it is possible to realize an optimum L1 converting resource. After the optimum L1 converting resource is realized, the calling connection request is transmitted so as to start the communication.

A fourth embodiment is explained with reference to FIG. 9. FIG. 9 is a general

20 view for a testing device in a base point device according to the fourth embodiment. The testing device shown in FIG. 9 is disposed in the base point device. The testing device shown in FIG. 9 is provided with a return controlling device 90 for separating the user's device 20-1 and the OVPN and returning a test beam which is transmitted from the OVPN and an optical switch 91.

25 Fifth Embodiment

A fifth embodiment is explained with reference to FIG. 10. FIG. 10 is a view for explaining a structure for an OVPN according to the fifth embodiment. In the OVPN shown in FIG. 10, converters 34 and 35 are not provided in the OVPN terminating devices 30-1 and 30-2. Instead, a collective converting device 100 is provided in the

5   OVPN. Also, an optical switch controlling device 131, an optical switch 132, and converters 34 and 35 are provided in the collective converting device 100 such that a plurality of OVPN terminating devices 30-1 and 30-2 can use the converters 34 and 35 commonly.

Here, in such a case in which a plurality of collective converting devices are

10   provided, a collective converting device which is disposed nearest to the OVPN terminating device is selected. In such a case, if the collective converting device which is disposed nearest to the OVPN terminating device is occupied, a collective converting device which is selected among the rest of the devices which are disposed to the OVPN terminating device

15   Sixth Embodiment

A sixth embodiment is explained with reference to FIGS. 2, and 11 to 13. FIG. 2 is a view for explaining a structure for the OVPN according to the first embodiment. FIGS. 11 and 13 are sequence diagrams for setting up a network according to the sixth embodiment. FIG. 12 is a block diagram for an optical switch controlling device

20   according to the sixth embodiment.

Next, operations in the sixth embodiment is explained with reference to FIGS. 11 and 12. Here, explanation is made for a case in which a user's device 20-1 is connected to the OVPN terminating device 30. When the user's device 20-1 is connected (step 1) to a network connecting terminal which is disposed in the OVPN

25   terminating device 30 which is disposed near the user who transmits the calling

connection request, the user's device 20-1 registers the L1 signal which is used in the

user's device 20-1 for the optical switch controlling device 31 (step 2). The user's

device 20-1 notifies the L1 signal type information which is used in the user's device

20-1 to a signal conversion determining section 16 in the optical switch controlling

5   device 31 via a control line. The L1 signal type information which can be converted by

the converters 33 and 34 and a usage condition information for an optical switch 32 are

inputted in the signal conversion determining section 16. Thus, the signal conversion

determining section 16 acknowledges the vacancy condition in the converters 33 and 34.

The signal conversion determining section 16 determines whether or not the L1 signal

10   type which is desired by the user's device 20-1 can be available presently with reference

to the L1 signal type information which is notified from the user's device 20-1 and the

usage condition information which is inputted from the optical switch 32

Here, two cases can be indicated for determining "whether or not L1 signal type

which is desired by the user's device 20-1 can be available presently". One is a case in

15   which the OVPN is not provided with a converting function initially. Another is a case

in which the OVPN is provided with a converting function but the converting function is

performed in the other OVPN. In the former case, it is acceptable to determine that the

L1 signal type cannot be used. However, in the latter case, it is acceptable to tentatively

determine that the L1 signal type can be used so as to await the resource to be usable.

20   In the latter case, a determining standard for whether determining that the L1 signal type

cannot be used or tentatively determining that the L1 signal type can be used depends on

the usage condition of the OVPN. That is, if the usage condition is that the user starts

immediately after the registration is completed, it is determined that the L1 signal type

cannot be used even in a case in which the converting resource is provided by occupied.

25   Also, under a usage condition in which actual communication starts after a certain period

of time after the registration is completed by the user it is determined that the L1 signal

type can be used if the converting resource is provided notwithstanding that it is

occupied.

If it is usable (there is a corresponding L1 resource), an IP address and a VPNID

·5   which do not overlap other user's device are generated by an address generating section

17.   The generated IP address and the VPNID are notified to the user's device 20-1.

Furthermore, the generated IP address, VPNID, the corresponding IP address, and the L1

signal type which is used in the user's device 20-1 of the VPNID are recorded in the

database 18 (step 3).

10   By doing this, the user's device 20-1 transmits to the network (step 4) by the L1

signal type which the user's device 20-1 desires.   In such a case, the IP address and the

VPNID are generated in the user who receives the calling connection request in a similar

manner.   The user's device 20-1 transmits the calling connection request by designating

the IP address to which the calling connection request should be arrived.   By doing this,

15 . a signaling operation is performed to the user who receives the calling connection request

(step 5); thus, a setting-up operation for the network is completed (step 6).

In this case, when the OVPN terminating device 30 receives the calling

connection request from the user's device 20-1, the OVPN terminating device 30 selects

the signal format which is used by the user who receives the calling connection request

20   based on the first signal format type information which is registered which is applied to

the user's device 20-1 for the IP address from which the calling connection request is

transmitted from which is contained in the calling connection request.   The selected

signal format information is transmitted to the user who receives the calling connection

request together with the calling connection request.

25   Here, it is acceptable if a encapsulating section is provided in place of the

converters 33 and 34 such that the first signal format #1 which is transmitted from the user's devices 20-1 and 21-1 should be encapsulated by the second signal format #2 so as to be transmitted to the SDH network, and a signal which is encapsulated by the second signal format #2 which is transmitted from the SDH network is de-encapsulated by the

5   first signal format #1 so as to be transmitted to the user's device 20-2.

As shown in FIG. 13, if there is not a vacant L1 resource for registering the L1 signal from the user's device (step 2), information for the L1 resource which indicates that other resource is vacant is notified to the user's device (step 3). If it is possible to change the L1, the user's device changes the L1 and registers the changed L1 signal (step

10   4). If there is a vacant L1 resource for the changed L1 signal, as explained above, the IP address and the VPNID are generated. Here, if it is not possible to change the L1 for the user's device, the user's device registers the L1 after a certain period of time. Alternatively, the user's device changes the L1 so as to register again.
Seventh Embodiment

15   A seventh embodiment is explained with reference to FIG. 14. FIG. 14 is a sequence diagram for explaining a setting-up steps for a network according to the seventh embodiment. Here, explanations are made for focusing the user's device 20-1. The steps from the step 1 to the step 3 are the same as those in the sixth embodiment; explanations and drawings are omitted so as to avoid duplicated explanation. When the

20   OVPN terminating device 30 receives the calling connection request (transmission) from the user's device 20-1 (step 4), the calling connection request to the user who receives the calling connection request at the IP address to which the calling connection request is transmitted which is contained in the calling connection request is transmitted (step 5) together with the first signal format type information which is registered and applied to

25   the user's device 20-1. The user who receives the calling connection request determines

whether or not the received calling connection request is the same as the signal format

which can be received by the user with reference to the format type information. If it is

determined that it is possible to receive, a communication starts as explained in the first

embodiment. If it is determined that it is not possible to receive the calling connection

5   request, the user who receives the calling connection request changes the signal format in

a receivable form (step 7) so as to notify that it is possible to receive the calling

connection request to the user who transmits the calling connection request (steps 8 and

9). Thus, the user who receives the calling connection request can receive the signal

from the user's device 20-1 by the L1 which is receivable for the user who receives the

10 calling connection request.

        If there is not a signal format which is receivable by the user who receives the

calling connection request, information for indicating that there is not a signal format

which is receivable by the user who receives the calling connection request is transmitted

to the user's device 20-1 as a response to the calling connection request as indicated by a

15 broken line. In such a case, the user's device 20-1 does not have function for receiving

the signal format which is returned as a response from the user who receives the calling

connection request; thus, the OVPN terminating device 30 receives the response so as to

notify that the network is not set up successfully due to that the signal format do not

coincide each other to the user's device 20-1.

20   An eighth embodiment is explained with reference to FIG 15. FIG. 15 is a

sequence diagram for explaining a setting-up steps for a network according to the eighth

embodiment. In the eighth embodiment, when the L1 signal of the user's device 20-1 is

registered (step 2) and a retrieved result indicates that "there is not a desired L1 resource"

according to the current usage condition for the optical switch, the OVPN terminating

25 device 30 retrieves other user's device which is using the L1 resource and inquires

whether or not it is possible to change to other vacant L1 resource to the other user's

device (step 3). If such an inquiry result indicates that it is possible to change to other

vacant L1 resource (step 4), the OVPN terminating device 30 requests to the other user's

device to change the L1 resource and generates the IP address and the VPNID for the

5 user's device 20-1 (steps 5 and 6).

A ninth embodiment is explained with reference to FIGS. 16 and 17. FIG. 16 is

a view for a structure of an OVPN according to the ninth embodiment. FIG. 17 is a

block diagram for a base point device according to the fourth embodiment. According

to the ninth embodiment, the OVPN terminating device 30 is provided with a base point

10 device 23 which identifies the first signal format type which is transmitted from the users

devices 20-1 and 21-1. An optical switch controlling device 31 determines whether or

not it is possible to convert the signal as explained in the first embodiment based on the

identified result conducted by the base point device 23 and generates the IP address and

the VPNID, and performs the registration therefor.

15 FIG. 17 shows a structure of the base point device 23. The base point device

23 is provided with a plurality of error detecting sections 7-1 to 7-3, and a signal

determining section 8. The error detecting sections 7-1 to 7-3 are disposed so as to

perform a simulation for calculation for a particular signal format. In such a simulation

for calculation, a signal format which is except a particular kind of signal format causes

20 error. The signal determining section 8 monitors a result in the simulation for

calculation which is performed by the error detecting sections 7-1 to 7-3. By detecting

any error detecting sections 7-1 to 7-3 in which error does not occur, an inputted signal

format type is specified. Such a determined result is notified to the optical switch

controlling device 31. The steps thereafter are the same as those explained in the sixth

25 embodiment.

An address maintaining section 9 is provided so as to maintain the IP address and the VPNID which are generated for the users device 20-1; thus, the IP address and the VPNID are notified according to an inquiry from the users device 20-1.

Here, for other method for determining the signal format type, there is a

5   following method. In this method, inputted signals are inputted into the converters 33 and 34 by the optical switch 32 so as to monitor an occurrence of error. If any converter 33 or 34 in which an error does not occur is found, it is possible to determine that the signal format which is handled in such a converter is the signal format of the inputted signal.

10   Tenth Embodiment

A tenth embodiment is explained with reference to FIG. 18. FIG. 18 is a sequence diagram for setting up a network according to the tenth embodiment. In the tenth embodiment, the user's device 20-1 can register a plurality of L1 signals which can be applied in the user's device 20-1. When the user's device 20-1 registers a plurality

15   of L1 signals (step 2), the signal conversion determining section 16 acknowledges vacancy in the L1 resource with reference to the current condition information for the usage of the optical switch. If it is indicated as "vacant" for the L1 signal, a corresponding IP address and a VPNID are generated (step 3). That is, an IP address is generated to an L1 signal type.

20   The user's device 20-1 transmits the calling connection request by using the IP address which corresponds to the L1 signal so as to perform communication by selecting an L1 signal among a plurality of L1 signals which are usable for the user's device 20-1. The OVPN terminating device 30 acknowledges the L1 signal which corresponds to the IP address and changes a direction of the optical switch 32 to a predetermined direction.

25   Also, the address maintaining section 9 which is explained as a base point

device shown in FIG. 8 maintains the VPNID and a plurality of IP addresses together with a plurality of L1 signal format information which correspond to the IP addresses.

Eleventh Embodiment

An eleventh embodiment is explained with reference to FIG. 19.   FIG. 19 is a

5   view for a structure of a testing device in a base point device according to the eleventh embodiment.   The testing device shown in FIG. 19 is disposed in the base point device so as to separate the user's device 20-1 and the OVPN.   The testing device is also provided with a returning controlling device 90 for returning a test beam which is transmitted from the OVPN back to the OVPN and an optical switch 91.

10   Twelfth Embodiment

A twelfth embodiment is explained with reference to FIG. 20.   FIG. 20 is a view for explaining a structure for the OVPN according to the twelfth embodiment.   A plurality of sub-OVPNs are connected each other in the OVPN shown in FIG. 20.   L1 signal converting devices 110 are disposed among all of the sub OVPNs; thus, it is

15   possible to handle a plurality of L1 signal type while converting the L1 signal.   The L1 signal converting device 110 is the same as the optical switch controlling device 31, an optical switch 32, a converters 35 and 36 in the OVPN terminating device.

Thirteenth Embodiment

A thirteen embodiment is explained with reference to FIGS. 2, and 21 to 24.

20   FIG. 2 is a view for a structure of the OVPN according to the thirteenth embodiment. FIG. 21 is a block diagram for an optical switch controlling device according to the thirteen embodiment.   FIG. 22 is a block diagram for a signal determining section according to the thirteenth embodiment.   FIG. 23 is a view for showing a registering pattern for database according to the thirteenth embodiment.   FIG. 24 is a flow chart for

25   showing operations in the thirteenth embodiment.

That is, the OVPN terminating device 30 according to the present embodiment

is provided with converters 33 and 34 for converting the first signal format and the

second signal format alternately when the first signal format which is used in the user's

device 20-1 which belongs to an OVPN subscriber and the second signal format which is

5   used in the OVPN are different from each other.   The converters 33 and 34 are provided

with a plurality of connection detecting sections 142 which contains the user's device

20-1 of the OVPN subscriber so as to correspond to a plurality of different first signal

format and detect whether or not the user's device 20-1 is connected thereto as shown in

FIG. 2, an address generating section 154 for generating the IP address and the VPNID to

10   the user's device 20-1 by the control channel when the detected result indicates that the

user's device 20-1 is connected thereto, a signal determining section 37 for receiving at

least a test signal which is transmitted via the data channel from the user's device 20-1 by

using the IP address so as to determine at least a first signal format type which belongs to

the user's device 20-1, and a signal conversion determining section 38 for retrieving

15   whether or not there are converters 33 and 34 which correspond to the format type

information according to the determined result by the signal determining section 37 when

the first signal format type which is used in the user's device 20-1 is different from the

second signal format type.   The signal conversion determining section 38 is

characterized in registering the IP address and the VPNID which are generated by the

20   address generating section 154 and the first signal format type information which is

determined by the signal determining section 37 which is applied to the user's device

20-1 for which the IP address and the VPNID are generated in to a database 148 when the

retrieved result indicates that the user's device 20-1 is connected thereto.

FIG. 22 shows a structure for the signal determining section 37.   The signal

25   determining section 37 is provided with error detecting sections 7-1 to 7-3 and a signal

determining device 8. The error detecting sections 7-1 to 7-3 are disposed so as to perform a simulation for calculation for a particular signal format. In such a calculation simulation process, a signal format which is except a particular kind of signal format causes error. The signal determining section 8 monitors a result in the calculation

5   simulation process which is performed by the error detecting sections 7-1 to 7-3. By detecting any error detecting sections 7-1 to 7-3 in which error does not occur, an inputted signal format type is specified. Such a determined result is notified to the signal conversion determining section 38.

       An address maintaining section 9 is provided so as to maintain the IP address

10   and the VPNID which are generated for the users device 20-1; thus, the IP address and the VPNID are notified according to an inquiry from the users device 20-1.

       In such a case, as shown in FIG. 29, the signal conversion determining section 38 registers a port identifier for the signal conversion determining section 38 which corresponds to at least the first signal format which is used in the user's device 20-1 and

15   an interface identifier into a database 148. By doing this, it is possible to set a direction of the optical switch 32 by the port identifier and the interface identifier.

       · Here, for other method for determining the signal format type, there is a following method. In this method, inputted signals are inputted into the converters 33 and 34 by the optical switch 32 so as to monitor an occurrence of error. If any converter

20   33 or 34 in which an error does not occur is found, it is possible to determine that the signal format which is handled in such a converter is the signal format of the inputted signal.

       Next, operations in the thirteenth embodiment is explained with reference to FIG.

23. When a connection detecting section 142 shown in FIG. 21 detects that the user's

25   device 20-1 is connected (step 10), the address generating section 154 generates the IP

address and the VPNID so as to transmit to the user's device 20-1 (step 11). When the

user's device 20-1 receives the IP address and the VPNID, the user's device 20-1

transmits a test signal to a data line by using the IP address. The signal determining

section 37 receives the test signal (step 12) so as to determine the signal type (step 13).

5   After the signal type is determined in such a manner, the determined result is notified to

the signal conversion determining section 38; thus, it is determined whether of not there

is a converting resource (step 14). If it is determined that there is a converting resource

(step 14), a registering operation is performed to the database 148. If it is determined

that there is not a converting resource (step 14), it is notified to the user's device 20-1

10   that it is not possible to perform a registering operation (step 16).

Here, there are two cases in which it is determined that there is not a converting

resource by the signal conversion determining section 38. One is a case in which the

OVPN is not provided with a converting resource initially. Another is a case in which

the OVPN is provided with a converting resource but the converting resource is occupied

15   in the other OVPN. In the former case, it is acceptable to determine that there is not a

converting resource. However, in the latter case, it is acceptable to tentatively

determine that there is a converting resource and await until the resource is vacant. In

the latter case, a determining standard for whether instantly determining that there is not

a converting resource or tentatively determining that there is a converting resource so as

20   to await depends on the usage condition of the OVPN. That is, if the usage condition is

that the user starts immediately after the registration is completed, it is determined that

the L1 signal type cannot be used even in a case in which the converting resource is

provided by occupied. Also, under a usage condition in which actual communication

starts after a certain period of time after the registration is completed by the user it is

25   determined that the L1 signal type can be used if the converting resource is provided

notwithstanding that it is occupied.

Fourteenth Embodiment

A fourteen embodiment is explained with reference to FIGS. 25 to 27. FIG. 25 shows a structure for an OVPN according to the fourteenth embodiment. FIG. 26 is a

5   block diagram for a base point device according to the fourteenth embodiment.

The base point device 23 in the fourteenth embodiment is characterized that the base point device 23 is provided with a connection detecting section 26 which is disposed between the OVPN terminating device 30 and the user's device 20-1 which is contained in the OVPN terminating device 30 so as to be connected to the user's device 20-1, an

10   address maintaining section 27 which receives and maintains the IP address and the VPNID which are generated for the address maintaining section 27 via the control channel from the OVPN terminating device 30, and a test signal transmitting section 28 which transmits at least the test signal based on the first signal format which is used in the user's device 20-1 to the user's device 20-1 via the data channel after the IP address

15   and the VPNID are generated to the OVPN terminating device 30.

The base point device 23 is connected to the OVPN terminating device 30, the control line, and the data line in advance. It is possible to employ any desirable method for connecting the user's device 20-1 and the base point device 23; thus, it is possible to realize a useful connecting condition for the user. For example, it is useful if a cable is

20   used for the connecting operation.

Also, the base point device 23 is disposed for the user by a network provider; thus, it is understood that the base point device 23 is a reliable device from a provider's point of view. Therefore, it is possible to avoid that the IP address and the VPNID may be used mischievously by transmitting the IP address and the VPNID of the user's device

25   20-1 to the base point device 23 in contrast to a case in which the IP address and the

VPNID are transmitted to the user's device of which reliability is not sufficiently realized. Also, it is possible to use a pattern which is set up by the network provider for the test signal pattern for determining the L1 type; thus, it is possible to obtain an optimum test signal.

5 Fifteenth Embodiment

A fifteenth embodiment is explained with reference to FIG. 27. FIG. 27 is a view for showing a testing device in the base point device in the fifteenth embodiment. The testing device shown in FIG. 27 disposed in the base point device is provided with a returning controlling device 90 for separating the user's device 20-1 and the OVPN and

10 returning the test beam which is transmitted from the OVPN back to the OVPN and an optical switch 91.

Sixteenth Embodiment

A sixteenth embodiment is explained with reference to FIG. 28. FIG. 28 is a view for explaining a structure of the OVPN according to the sixteenth embodiment. In

15 the OVPN shown in FIG. 28, the converters 33 and 34 are not provided in the OVPN terminating device 30-1 and 30-2. Instead, a collective converting device 100 is disposed in the OVPN. Also, an optical switch controlling device 131, an optical switch 132, and the converters 33 and 34 are disposed in the collective converting device 100. By doing this, it is possible for a plurality of OVPN terminating devices 30-1,

20 30-2 to use the converters 33 and 34 commonly.

Here, if a plurality of collective converting devices are provided, a collective converting device which is disposed in a shortest path to the OVPN terminating device is selected. In such a case, if the collective converting device which is disposed in the shortest path to the OVPN terminating device is occupied, the next shortest collective

25 converting device is selected.

Seventeenth Embodiment

A seventeenth embodiment is explained with reference to FIGS. 29 to 31. FIG. 29 is a view for explaining a structure of the OVPN in the seventeenth embodiment. FIG. 30 is a view for explaining an OVPN terminating device (No. 2) according to the

5   first embodiment. FIG. 31 is a view for explaining a encapsulating condition and a de-encapsulating condition according to the seventeenth embodiment.

As shown in FIG. 29, the OVPN terminating device 30 is provided with encapsulating sections 143 and 145 which encapsulate the first signal format which is transmitted from the user's devices 20-1 and 21-1 by the second signal format so as to

10   transmit to the OTN and de-encapsulate the signal which is encapsulated according to the second signal format #2 which is transmitted into the first signal format so as to transmit to the user's devices 20-1 and 21-2.

Here, if the same signal format is used in the user's device and the OVPN commonly, it is not necessary to perform a encapsulating operation at all. Thus, it is

15   possible to perform a communication without via the encapsulating sections 143, 146, 85, and 86. Such a case is not necessary for explaining technical features of the present invention; thus, such explanations are omitted. Therefore, transmitting paths are disposed in which the encapsulating sections 143, 146, 35, 36, 85, and 86 are not actually inserted. However, such transmission paths are omitted in the drawings.

20   That is, as shown in FIG. 29, the OVPN is provided with optical switches 32 to one of which end the user's devices 20-1, 21-1, and 22-1 are contained. Also, a cross connecting device 50 is connected to the other end of the optical switch 32. The encapsulating sections 143 and 146 are disposed at the port which faces the user's devices 20-1, 21-1, and 22-1 in the optical switch 32. By doing this, it is possible to

25   select either one of desirable encapsulating sections 143 or 146 by switching a direction

of the optical switches 32

Alternatively, as shown in FIG. 30, the OVPN is provided with optical switches 32 to one of which end the user's devices 20-1, 21-1, and 22-1 are contained. Also, a cross connecting device 50 is connected to the other end of the optical switches 32. The

5   encapsulating sections 143 and 146 are disposed at the port which faces the user's devices 20-1, 21-1, and 22-1 in the optical switch 32. Its conversion output returns to the port which contains the user's devices 20-1, 21-1, and 22-1 in the optical switch 32.

According to a disposition of the optical switch shown in FIG. 29, there is a case in which it is necessary to set up the optical cross connecting device 50 again according

10   to the disposition of the encapsulating sections when the encapsulating section 143 or 146 are switched by the optical switch 32. However, as shown in FIG. 29, by connecting the encapsulating sections 143 and 146 to the optical switch 32, it is not necessary to set up the optical cross connecting device 50 again.

Arrows in broken lines indicates a connecting condition of the optical switch 32.

15   The user's device 20-1 selects the encapsulating section 143. The user's device 21-1 selects the encapsulating section 146. A connecting condition of the optical switch 82 in the OVPN terminating device 80 is set accordingly. There are several methods for setting up the connecting conditions for the optical switches 32 and 80. In a method, a switching request which is sent to the optical switch controlling device 31 via a control

20   line near a transmitting device is transmitted to the optical switch controlling device 81 near a receiving device. Alternatively, there is a method in which the switching request is also transmitted from the user's device which receives the switching request. The embodiments of the present invention are not affected by any one of such methods. The layer 1 transparent exclusive line is changed according to the switching request from the

25   user.

The encapsulating sections 143 and 146 are disposed so as to correspond to the encapsulating operation and the de-encapsulating operation for different signal formats respectively. The encapsulating sections 143 and 146 which correspond to the desired signal format are selected by switching the optical switch 32.

5   Next, operations for a tunneling transmission for a data which is performed by the encapsulating operation and the de-encapsulating operation are explained. In FIG 31, the encapsulating devices 35 and 36 are OTN multiplying devices which are defined by ITU-TG 709. An Etherframe or an SDH frame is used for the layer 1 frame.

A mapping operation for the layer 1 frame which is transmitted from the user's

10   device 20-1 or 21-1 to the OVPN terminating device 30 is performed onto an ODU (Optical Data Unit) by the encapsulating sections 143 and 146. Furthermore, the encapsulating sections 143 and 146 generate an OTU (Optical Channel Transport Unit) from the OTU so as to handle based on a common format in the OTN. In such a case, the ODUs which are directed to a common destination are multiplied into an OTU by a

15   multiplying device 149.

Also, the ODU of the OTU which is transmitted from the OVPN to the OVPN terminating device 80 is extracted by the multiplying device 88. Furthermore, the layer 1 frame is extracted from the ODU in the encapsulating sections 85 and 86 so as to be transmitted to the user's device 20-2 or 21-2.

20   Eighteenth Embodiment

An eighteenth embodiment is explained with reference to FIGS. 32 to 34. FIG 32 is a view for explaining a structure of the OVPN in the eighteenth embodiment. FIG 33 is a view for explaining the OVPN terminating device (No. 2) in the eighteenth embodiment. FIG 34 is a view for explaining a encapsulating condition and a

25   de-encapsulating condition in the eighteenth embodiment. Here, explanation can be

made with reference to a case of SDH. However, explanation can be made even if the SDH is replaced by a SONET. In the eighteenth embodiment, as shown in FIG 32, a direction of an optical cross connecting device 50 is set by a network controlling device 40. Thus, an OVPN is disposed in which an SDH network is disposed between the base

5   points as a layer 1 transparent frame. Here, the network controlling device 40 can be controlled by the user's devices 20-1, 21-1, and 22-1 in each base point.

In an example shown in FIG 34, the encapsulating sections 143 and 146 shown in FIGS. 32 and 33 are SDH multiplying devices which are defined by ITU-TG 707. An SDH frame is used for a layer 1 frame.

10   As shown in FIG 34, a mapping operation for the layer 1 frame which is transmitted from the user's device 20-1 to the OVPN terminating device 30 is performed onto a VC (Virtual Container) in the encapsulating section 143. Furthermore, the encapsulating section 143 generates an STM (Synchronous Transfer Mode) frame so as to be handled under a common format in the SDH network. In such a case, if the SDH

15   cannot be contained in a VC, the SDH frame is divided into a plurality of frames by the multiplying device 150 so as to perform a mapping operation onto a plurality of VCs by a plurality of encapsulating sections 143. Thus, a plurality of STM frames are generated from a plurality of VCs.

Also, the VC of the STM frame which is transmitted from the OVPN to the

20   OVPN terminating device 80 is extracted at the encapsulating section 85. Furthermore, the layer 1 frames are extracted from a plurality of VCs by the multiplying device 89; thus, the SDH frames are restored so as to be transmitted to the user's device 20-2.

Also, it is possible to dispose the optical switches as shown in FIG 33 for the eighteenth embodiment.

25   Nineteenth Embodiment

A nineteenth embodiment is explained with reference to FIGS. 32, 33 and 35.

FIG. 32 is a view for explaining a structure of the OVPN in the eighteenth embodiment.

FIG. 33 is a view for explaining the OVPN terminating device (No. 2) in the eighteenth

embodiment.   FIG. 35 is a view for explaining a encapsulating condition and a

5   de-encapsulating condition in the nineteenth embodiment.   Here, explanation can be

made with reference to a case of SDH.   However, explanation can be made even if the

SDH is replaced by a SONET.   In the nineteenth embodiment, as shown in FIG. 32, a

direction of an optical cross connecting device 50 is set by a network controlling device

40.   Thus, an OVPN is disposed in which an OTN is disposed between the base points

10   as a layer 1 transparent frame.   Here, the network controlling device 40 can be

controlled by the user's devices 20-1, 21-1, and 22-1 in each base point.

In an example shown in FIG. 35, the encapsulating section 143 shown in FIGS.

32 and 33 are OTN multiplying devices which are defined by ITU-TG 709.   An SDH

frame is used for a layer 1 frame.

15   As shown in FIG. 35, a mapping operation for the layer 1 frame which is

transmitted from the user's device 20-1 to the OVPN terminating device 30 is performed

onto an ODU in the encapsulating section 143.   Furthermore, the encapsulating section

143 generates an OTU from the ODU so as to be handled under a common format in the

OTN.   In such a case, if the SDH cannot be contained in a ODU, the SDH frame is

20   divided into a plurality of frames by the multiplying device 150 so as to perform a

mapping operation onto a plurality of ODUs by a plurality of encapsulating sections 143.

Thus, a plurality of OTUs are generated from a plurality of ODUs.

Also, the ODU of the OTU which is transmitted from the OVPN to the OVPN

terminating device 80 is extracted at the encapsulating section 143.   Furthermore, an

25   SDH frame is restored from a plurality of SDH frames by the multiplying device 89; thus,

the SDH frames are restored so as to be transmitted to the user's device 20-2.

Also, it is possible to dispose the optical switches as shown in FIG. 33 for the nineteenth embodiment.

The eighteenth embodiment and the nineteenth embodiment are compared each other. In the eighteenth embodiment, a transmission rate for the layer 1 frame which is transmitted from the user's device 20-1 and a transmission rate for the STM frame in the OVPN is almost equal. Thus, the transmission rate in the OVPN is reduced in accordance with a encapsulating operation for the layer 1 frame. In contrast, in the nineteenth embodiment, the transmission rate for the OTU in the OVPN is faster than the transmission rate for the layer 1 frame which is transmitted from the user's device 20-1; thus, the transmission is not reduced in accordance with a encapsulating operation for the layer 1 frame.

Twentieth Embodiment

A twentieth embodiment is explained with reference to FIGS. 36 and 37. FIG. 36 is a view for explaining the OVPN terminating device in the twentieth embodiment. FIG. 37 is a view for explaining the OVPN terminating device (No. 2) in the twentieth embodiment. The OVPN terminating device shown in the seventeenth embodiment to nineteenth embodiment is combined with a structure shown in FIGS. 36 and 37. Processes which are explained in the seventeenth embodiment to the nineteenth embodiment can be preferably performed according to necessity.

Twenty-first Embodiment

A twenty-first embodiment is explained with reference to FIGS. 38 to 40. FIG. 38 is a view for explaining a structure for the OVPN in the twenty-first embodiment. FIG. 39 is a view for explaining a structure for the OVPN in the twenty-first embodiment. FIG. 40 is a view for explaining a structure for the OVPN in the twenty-first embodiment.

The seventeenth embodiment to the twentieth embodiment relate to the OVPN

terminating device. In contrast, the OVPN terminating device is not disposed in the

twenty-first embodiment. That is, collective converting devices 100, 101, and 102 are

disposed in the OVPN so as to perform a collective function such as a encapsulating

5   operation and a de-encapsulating operation as explained in the seventeenth embodiment

to the twentieth embodiment.

That is, as shown in FIG. 38, a collective converting device 100 provided with

an optical switch controlling device 31, an optical switch 32, encapsulating sections 143,

146, and a multiplying device 149 is disposed in a rear stage of the optical cross

10   connecting device 50. In FIG. 38, a plurality of optical cross connecting devices are

connected to the optical switch 32 in addition to the optical cross connecting device 50 so

as to handle the optical switch controlling device 31, the optical switch 32, the

encapsulating sections 143 and 146, and the multiplying device 149 commonly. By

doing this, in the seventeenth embodiment to the twentieth embodiment, the optical

15   switch controlling device 31, the optical switch 32, the encapsulating sections 143 and

146, and the multiplying device 149 which are disposed in each OVPN terminating

device are disposed in the OVPN. Alternatively, it is acceptable if a plurality of the

optical switch controlling device 31, a plurality of the optical switch 32, a plurality of the

encapsulating sections 143 and 146, and a plurality of the multiplying device 149 are

20   disposed in the OVPN. Thus, the optical cross connecting device uses the optical

switch controlling device 31, the optical switch 32, the encapsulating sections 143 and

146, and the multiplying device 149 commonly. By doing this, it is possible to use the

network resource efficiently. Here, it is necessary to set the direction of the output from

the multiplying device 149 by the optical cross connecting device 51; thus, it is necessary

25   to dispose a network controlling device 41 and the optical cross connecting device 51 in

addition to the network controlling device 40 and the optical cross connecting device 50.

Similarly, a collective converting device 101 which is provided with a multiplying device 150, an optical switch controlling device 31, the optical switch 32, the encapsulating sections 143 and 146 in a rear stage of the optical cross connecting device

5   50 (the encapsulating section 146 is omitted in the drawing). In FIG 39, a plurality of optical cross connecting devices are connected to the multiplying device 150 in addition to the optical cross connecting device 50 so as to handle the multiplying device 150, the optical switch controlling device 31, the optical switch 32, and the encapsulating sections 143 and 146. By doing this, in the seventeenth embodiment to the twentieth

10   embodiment, the optical switch controlling device 31, the optical switch 32, the encapsulating sections 143 and 146, and the multiplying device 150 which are disposed in each OVPN terminating device are disposed in the OVPN. Alternatively, it is acceptable if a plurality of the optical switch controlling device 31, a plurality of the optical switch 32, a plurality of the encapsulating sections 143 and 146, and a plurality of

15   the multiplying device 150 are disposed in the OVPN. Thus, the optical cross connecting device uses the optical switch controlling device 31, the optical switch 32, the encapsulating sections 143 and 146, and the multiplying device 150 commonly. By doing this, it is possible to use the network resource efficiently. Here, it is necessary to set the direction of the output from the optical switch 32 by the optical cross connecting

20   device 51; thus, it is necessary to dispose a network controlling device 41 and the optical cross connecting device 51 in addition to the network controlling device 40 and the optical cross connecting device 50. Here, if a plurality of collective converting devices are provided, a collective converting device which is disposed in a shortest path to the OVPN terminating device is selected. In such a case, if the collective converting device

25   which is disposed in the shortest path to the OVPN terminating device is occupied, the

next shortest collective converting device is selected.

As shown in FIG. 40, it is possible to dispose a collective converting device 102 in which structures shown in FIGS. 38 and 39 are combined. By doing this, it is possible to perform the processes which are explained in FIGS. 38 and 39 preferably

5 according to necessity.

Twenty-second Embodiment

A twenty-second embodiment is explained with reference to FIGS. 41 and 42. FIG. 41 is a view for explaining a frame-multiplying-operation in the twenty-second embodiment. FIG. 42 is a view for explaining a frame-dividing-operation in the

10 twenty-second embodiment. In the seventeenth embodiment to the twenty-first embodiment, an OTN is used for the layer 1 transparent exclusive network. However, the OVPN produces a private network virtually; therefore, it is not necessary that the layer 1 network should be actually realized in the OVPN as long as the inside of the OVPN looks like a layer 1 network to the user. That is, it is acceptable if the inside of

15 the OVPN is a layer 2 network or a layer 3 network. For an IP network, the layer 3 network is employed. In the twenty-second embodiment, explanations are made for a case in which the IP network is employed for the layer 1 transparent exclusive network.

That is, the OTN in the FIG. 17 is replaced by an IP network. The optical cross connecting devices 50 and 70 are replaced by a router for processing an IP packet. In an

20 example shown in FIG. 41, the encapsulating operation for the SDH frame or the Ether frame is performed by the IP packet in the encapsulating section 143 or 146. The multiplying device 149 multiplies the SDH frame and the Ether frame which are encapsulated into the IP packet per a common destination. Such processes are realized by an IP-multiplying-operation by using an IP header. Also, in an example shown in

25 FIG. 42, an SDH frame is divided into two frames so as to be added an IP header

respectively.

By doing this, an IP transmission for the SDH frame or the Ether frame which are encapsulated by the IP packet is performed in the IP network as a layer 1 transparent exclusive network. The operations thereafter are the same as those in the former

5 embodiments. By doing this, in the twenty-second embodiment, it is explained that it is possible to realize the layer 1 transparent exclusive network by various layer networks.

Twenty-third Embodiment

A twenty-third embodiment is explained with reference to FIGS. 43 to 45. FIG. 29 is a view for explaining a structure of the OVPN in the twenty-third embodiment.

10 FIG. 43 is a view for explaining an IP-encapsulating operation and an IP-de-encapsulating operation for the Ether frame and the SDH frame. FIG. 44 is a view for explaining an MPLS-encapsulating operation and an MPLS-de-encapsulating operation for the Ether frame and the SDH frame. FIG. 45 is a view for explaining an OVPN terminating device (No. 2) in the twenty-third embodiment.

15 As shown in FIG. 29, the present embodiment is characterized in following points. The OVPN is provided with encapsulating sections 143, 146, 85 and 86 which convert the first signal format in the layer 1 which is employed in the user's device of an OVPN subscriber and the second signal format in an upper layer which is employed in the OVPN alternately. The encapsulating sections 143, 146, 85, and 86 contain the

20 user's devices 20-1, 21-1, 22-1, 20-2, and 21-2 of the OVPN subscriber which are disposed so as to correspond to a plurality of various first signal formats. The OVPN is provided the encapsulating sections 143, 146, 85, and 86 in thereinside. The encapsulating sections 143, 146, 85, and 86 perform a encapsulating operation for the first signal format which is transmitted from the user's devices 20-1 and 21-1 by the

25 second signal format so as to be transmitted to the OVPN. The signal which is

encapsulated by the second signal format which is transmitted from the OVPN is de-encapsulated into the first signal format so as to be transmitted to the user's devices 20-2 and 21-2.

In the present embodiment, an SDH frame and an Ether frame are used for an

5   example for the first signal format in the layer 1 which is used in the user's device. Also, an IP packet or an MPLS packet is used for the second signal format in an upper layer than the layer 1 which is used in the OVPN.   The OVPN in the present embodiment is provided with routers 151 and 88 for performing a multiplying operation and dividing operation for a plurality of signals by the second signal format.

10   In FIG. 29, an optical switch 32 is provided which contains the user's devices 20-1, 21-1, and 22-2 on an end of the optical switch and has an optical cross connecting device 50 on the other end of the optical switch 32.   The encapsulating sections 143 and 146 are disposed in a port which faces the user's devices 20-1, 21-1, and 22-2 in the optical switch 32.   By doing this, it is possible to select desirable encapsulating section

15   143 or 146 by switching the direction of the optical switch 32.

Otherwise, as shown in FIG. 45, an optical switch 32 is provided which contains the user's devices 20-1, 21-1, and 22-2 on an end of the optical switch and has an optical cross connecting device 50 on the other end of the optical switch 32.   The encapsulating sections 143 and 146 are disposed in a port which faces the user's devices 20-1, 21-1,

20   and 22-2 in the optical switch 32.   The converted output returns to the port which contains the user's devices 20-1, 21-1, and 22-2 in the optical switch 32 via the router 151.

According to a disposition of the optical switch shown in FIG. 29, there is a case in which it is necessary to set up the optical cross connecting device 50 again according

25   to the disposition of the encapsulating sections when the encapsulating section 143 or

146 are switched by the optical switch 32. However, as shown in FIG. 45, by connecting the encapsulating sections 143 and 146 to the optical switch 32, it is not necessary to set up the optical cross connecting device 50 again.

Arrows in broken lines indicates a connecting condition of the optical switch 32. The user's device 20-1 selects the encapsulating section 143. The user's device 21-1 selects the encapsulating section 146. A connecting condition of the optical switch 82 in the OVPN terminating device 80 is set accordingly. There are several methods for setting up the connecting conditions for the optical switches 32 and 80. In a method, a switching request which is sent to the optical switch controlling device 31 via a control line near a transmitting device is transmitted to the optical switch controlling device 81 near a receiving device. Alternatively, there is a method in which the switching request is also transmitted from the user's device which receives the switching request. The embodiments of the present invention are not affected by any one of such methods. The layer 1 transparent exclusive line is changed according to the switching request from the user.

The encapsulating sections 143 and 146 are disposed so as to correspond to the encapsulating operation and the de-encapsulating operation for different signal formats respectively. The encapsulating sections 143 and 146 which correspond to the desired signal format are selected by switching the optical switch 32.

Next, operations for a tunneling transmission for a data which is performed by the encapsulating operation and the de-encapsulating operation are explained. In FIG. 43, the encapsulating devices 143 and 146 are an IP-encapsulating device and a de-encapsulating device. An Etherframe or an SDH frame is used for the layer 1 frame which is used by the user. Hereinafter, explanations are made for an SDH, although, explanations can be made for SONET.

When the IP network is used for the OVPN, an IP header which is generated by the encapsulating sections 143 and 146 is add to the layer 1 frame which is transmitted from the user's device 20-1 or 21-1 to the OVPN terminating device 30. By doing this, the Ether frame is encapsulated by the IP packet by adding the IP header to the Ether

5   frame in the encapsulating section 143. Also, the SDH frame is encapsulated by the IP packet by adding the IP packet to the SDH frame in the encapsulating section 146. Furthermore, these IP packets are multiplied so as to be transmitted to the router 88 from the router 151. The router 88 designates the destination according to the IP header. Here, any network can be used for the layer 1 transparent exclusive network as long as it

10   is possible to transmit the IP packet which is multiplied from the router 151 to the router 88. In the present embodiment, an OTN is used. Therefore, the IP packet is further encapsulated in the OTU so as to be transmitted in the layer 1 transparent exclusive network.

Also, when an MPLS network is used for the OVPN, as shown in FIG. 44, the

15   second signal format is an MPLS frame when the first signal format is Ether frame and an SDH frame. In the encapsulating section 143, the Ether frame is encapsulated by the MPLS frame by adding a Shim header to the Ether frame. Also, an SDH frame is encapsulated by the MPLS frame in the encapsulating section 146 by adding the Shim header to the SDH frame. Furthermore, these MPLS frames are multiplied so as to be

20   transmitted from the router 151 to the router 88. In the router 88, the destination is designated according to the Shim header. Here, as explained above, any network can be used for the layer 1 transparent exclusive network as long as it is possible to transmit the MPLS frame which is multiplied from the router 151 to the router 88. In the present embodiment, an OTN is used. Therefore, the MPLS frame is further encapsulated in

25   the OTU so as to be transmitted in the layer 1 transparent exclusive network.

Also, each IP packet or each MPLS frame which are transmitted from the OVPN to the OVPN terminating device 80 are extracted by the router 88.   Furthermore, the Ether frame or the SDH frame is extracted from the IP packet or the MPLS frame in the encapsulating sections 85 and 86 so as to be transmitted to the user's device 20-1 or 21-2.

5   By doing this, it is possible to realize an OVPN in which it is possible to respond to a request for changing a signal format which is employed by the user quickly and transmit the signal in the OVPN efficiently by using a multiplying operation.

Twenty-fourth Embodiment

A twenty-fourth embodiment is explained with reference to FIGS. 46 to 49.

10   FIG 46 is a view for explaining a structure of the OVPN in the twenty-fourth embodiment.   FIG 47 is a view for performing an IP-encapsulating condition by dividing an SDH frame into a plurality of frames.   FIG 48 is a view for explaining an MPLS-encapsulating-operation by dividing an SDH frame into a plurality of frames. FIG 49 is a view for explaining an OVPN terminating device (No. 2) in the

15   twenty-fourth embodiment.   Here, in the twenty-fourth embodiment, explanation can be made with reference to a case of SDH.   However, explanation can be made even if the SDH is replaced by a SONET.   In the twenty-fourth embodiment, as shown in FIG 46, a direction of an optical cross connecting device 50 is set by a network controlling device 40.   Thus, an OVPN is disposed in which an SDH network is disposed between the base

20   points as a layer 1 transparent frame.   Here, the network controlling device 40 can be controlled by the user's devices 20-1, 21-1, and 22-1 in each base point.

In an example shown in FIG 47, the encapsulating sections 143 and 146 shown in FIGS. 46 and 49 are IP-encapsulating device and an IP-de-encapsulating device.   An SDH frame is used for a layer 1 frame.   An IP header is add to the layer 1 frame which

25   is transmitted from the user's device 20-1 to the OVPN terminating device 30 in the

encapsulating section 143 so as to be encapsulated in the IP packet. When the SDH

frame cannot be contained in an IP packet flow, the SDH frame is divided into a plurality

of frames by a multiplying device 150 so as to be encapsulated by a plurality of packet

flows by a plurality of encapsulating sections 143. Here, any network can be used for

5 the layer 1 transparent exclusive network as long as it is possible to transmit the IP packet

which is multiplied from the router 151 to the router 88. In the present embodiment, an

OTN is used. Therefore, the IP packet is further encapsulated in the OTU so as to be

transmitted in the layer 1 transparent exclusive network.

The IP header of the IP packet which is transmitted from the OVPN to the

10 OVPN terminating device 80 is extracted in the encapsulating section 85. Furthermore,

an SDH frame is restored from a plurality of SDH frames by the multiplying device 89 so

as to be transmitted to the user's device 20-2.

In an example shown in FIG. 48, the encapsulating section 143 and 146 shown

in FIGS. 46 and 49 are an MPLS encapsulating device and an MPLS de-encapsulating

15 device. An SDH frame is used for a layer 1 frame. The Shim header is added to the

layer 1 frame which is transmitted from the user's device 20-1 to the OVPN terminating

device 30 in the encapsulating section 143 so as to be encapsulated in the MPLS frame.

In such a case, if the SDH cannot be contained in an MPLS frame flow, the SDH frame is

divided into a plurality of frames by the multiplying device 150 so as to be encapsulated

20 in a plurality of MPLS frame flows by a plurality of encapsulating sections 143. Here,

as explained above, any network can be used for the layer 1 transparent exclusive

network as long as it is possible to transmit the MPLS frame which is multiplied from the

router 151 to the router 88. In the present embodiment, an OTN is used. Therefore,

the MPLS frame is further encapsulated in the OTU so as to be transmitted in the layer 1

25 transparent exclusive network.

Also, the Shim header of the MPLS frame which is transmitted from the OVPN

to the OVPN terminating device 80 is removed in the encapsulating section 85.

Furthermore, an SDH frame is restored from a plurality of SDH frames by the

multiplying device 89 so as to be transmitted to the user's device 20-2.   Also, it is

5   possible to dispose an optical switch as shown in FIG. 49 in the twenty-fourth

embodiment.

By doing this, it is possible to realize an OVPN in which it is possible to

respond to a request for changing the signal format which is employed by the user and set

a length of the signal desirably by transmitting a long signal by dividing therefore.

10   In examples shown in FIGS. 36 and 37, when processes which are explained in

the twenty-third embodiment are performed, the multiplying device 150 is under a

through-condition by stopping a multiplying function and a dividing function so as to use

the encapsulating sections 143 and 146, and a router 151.   Also, when processes which

are explained in the twenty-fourth embodiment are performed, the multiplying device

15   150, the encapsulating sections 143 and 146, and the router 151 are used.   In such a

structure, a router is used in place of a multiplying device of the nineteenth embodiment.

It is possible to realize the same effect as that realized in the nineteenth embodiment by

such a structure.

Also, it is possible to dispose a collective converting device to which structure

20   shown in FIGS. 38 and 39 is combined.   By doing this, it is possible to perform the

processes which are explained with reference to FIG. 38 or FIG. 39 preferably.   Such a

structure is the same as that shown in FIG. 39.   That is, the structure of the FIG. 38 is

realized by the structure of the FIG. 39 by stopping the multiplying function and the

dividing function in the multiplying device 150 so as to be under a through-condition

25   such that the multiplying function and the dividing function are performed by the router

151.

Twenty-fifth Embodiment

A twenty-fifth embodiment is explained with reference to FIGS. 52 to 58. FIG. 52 is a view for explaining a structure of an OVPN in the present embodiment. FIG. 53

5   is a block diagram for a base point device in the present embodiment. FIG. 54 is a block diagram for an optical switch controlling device in the present embodiment. FIG. 55 is a sequence diagram for explaining operations in the present embodiment. FIG. 56 is a view for explaining a determining operation for the L1 signal in the present embodiment. FIG. 57 is a block diagram for a separating testing device in the present embodiment.

10   FIG. 58 is a block diagram for a collective converting device in the present embodiment.

A direction of the optical cross connecting device 50 is set by the network controlling device 40 such that an OVPN is formed so as to have an SDH network among the base points. Here, it is possible to control the network controlling device 40 by the user's devices 20-1 and 21-1 in each base point.

15   In the twenty-fifth embodiment, the OVPN terminating device 30 is provided with converters 33 and 34 as signal converters for converting a Gigabit Ethernet or an ATM which are the first signal format which are employed in the user's devices 20-1, 20-1, and 21-1 and an SDH which is the second signal format which is different from the first signal format which is employed in the OVPN alternately. A plurality of converters

20   33 and 34 are disposed so as to correspond to a plurality of different first signal formats. By controlling the optical switch 32, it is determined which converter 33 or 34 to use.

Here, if the same signal format is used in the user's device and the OVPN commonly, it is not necessary to switch the signal at all. Thus, it is possible to perform a communication without via the converters 33 and 34. Such a case is not necessary for

25   explaining technical features of the present invention; thus, such explanations are

omitted.

Also, it is possible to use the OVPN as long as it is possible to convert the signal format which is used in the user's device 20-1 and the signal format which is used in the user's device 20-2 under conditions in which the signal format which is used in the user's

5 device 20-1 and the signal format which is used in the user's device 20-2 are different from each other. Here, in order to simplify the explanation, explanations are made under conditions in which the signal formats are the same.

That is, the OVPN terminating device 30 in the present embodiment is provided with converters 33 and 34 for converting the first signal format and the second signal

10 format alternately as shown in FIG. 52 when the first signal format which is used in the user's device 20-1 of the OVPN describer and the second signal format which is used in the OVPN are different from each other. A plurality of the converters 33 and 34 are disposed so as to correspond to a plurality of different first signal formats. As shown in FIG. 3, the optical switch controlling device 31 is provided with a notification receiving

15 section 144 for receiving a notice that the user's device 20-1 is connected to the base point device 23 via a control channel from the base point device 23 which is disposed between the user's device 20-1 and the OVPN and an address generating section 154 for transmitting the IP address and the VPNID which are allocated to the user's device 20-1 for the base point device 23.

20 Furthermore, the OVPN terminating device 30 is provided with a connection processing section 147 for receiving a receipt confirmation for the IP address and the VPNID which are transmitted from the address generating section 154 and transmitting a final connection confirmation for notifying the receipt confirmation to the base point device 23.

25 Furthermore, the OVPN terminating device 30 is provided with a signal

conversion determining section 38. The signal conversion determining section 38

receives the first signal format type information which is employed in the user's device

20-1 by the control channel after the final connection confirmation is transmitted and

retrieves whether or not there is a converter 33 or 34 which corresponds to the format

5   type. The signal conversion determining section 38 registers the IP address and the

VPNID which are allocated to the user's device 20-1 and the first signal format type

information which is employed in the user's device 20-1 into the database 39 when the

retrieved result indicates that there is a converter 33 or 34 which corresponds to the

format type.

10   Here, there are two cases in which it is retrieved that there is not a converting

resource by the signal conversion determining section 38. One is a case in which the

OVPN is not provided with a converting function initially. Another is a case in which

the OVPN is provided with a converting function but the converting resource is occupied

in the other OVPN. In the former case, it is acceptable to determine that there is not a

15   converting resource. However, in the latter case, it is acceptable to tentatively

determine that there is a converting resource and await until the resource is vacant. In

the latter case, a determining standard for whether instantly determining that there is not

a converting resource or tentatively determining that there is a converting resource so as

to await depends on the usage condition of the OVPN. That is, if the usage condition is

20   that the user starts immediately after the registration is completed, it is determined that

the L1 signal type cannot be used even in a case in which the converting resource is

provided by occupied. Also, under a usage condition in which actual communication

starts after a certain period of time after the registration is completed by the user it is

determined that the L1 signal type can be used if the converting resource is provided

25   notwithstanding that it is occupied.

Also, as shown in FIG. 53, the base point device 23 which is inserted between

the OVPN terminating device 30 and the user's device 20-1 which is contained in the

OVPN terminating device 30 is provided with a connection detecting section 136 for

detecting a fact that the user's device 20-1 is connected to the base point device 23, a

5 connection notifying section 138 for notifying that the connection detecting section 136

is connected to at least an OVPN terminating device 30 via the control channel when it is

detected that the connection detecting section 136 is connected, and an address

maintaining section 27 for receiving the IP address and the VPNID which are allocated

from at least an OVPN terminating device 30 to the user's device 20-1 via the control

10 channel.   The address maintaining section 27 is provided with a registering section 29

which transmits the receipt confirmation to an OVPN terminating device 30 which

receives the IP address and the VPNID and transmits the first signal format type

information, the IP address, and the VPNID which are used by the user's device 20-1 to

the OVPN terminating device 30 which receives the final connection confirmation for the

15 receipt confirmation via the control channel.

Next, operations in the present embodiment are explained with reference to FIG.

55.   When the user's device 20-1 is connected to the base point device, the connection

detecting section 136 in the base point device 23 detects that the user's device 20-1 is

connected to the base point device (step 17).   A detected output from the connection

20 detecting section 136 is inputted to a connection notifying section 138, the connection

notifying section 138 receives the inputted detection output so as to transmit a connection

notification (step 18).   A notification receiving section 144 in the OVPN terminating

device 30 receives the connection notification so as to transmit the IP address and the

VPNID of the base point device 23 (step 19).   The address maintaining section 27 in the

25 base point device 23 receives the IP address and the VPNID so as to transmit the receipt

confirmation to the OVPN terminating device 30 (step 20). In such a case, the

connection confirmation is received by a plurality of OVPN terminating devices except

the OVPN terminating device 30; thus, the IP address and the VPNID are transmitted to

the base point device 23 from a plurality of the OVPN terminating devices. The address

5   maintaining section 27 selects an IP address and a VPNID among a plurality of IP

addresses and a plurality of VPNIDs. Here, an OVPN terminating device 30 which is

disposed nearest to the base point device 23 is selected. More specifically, an OVPN

terminating device to which the IP address and the VPNID arrive fastest is selected.

When the connection processing section 147 in the OVPN terminating device 30

10   receives the receipt confirmation, the connection processing section 147 transmits the

final connection confirmation to the base point device 23 (step 21). When the final

connection confirmation arrives at a registering section 29, the registering section 29

transmits the IP address and the VPNID which are maintained in the address maintaining

section 27 to the OVPN terminating device 30 together with the L1 type information

15   which is used in the user's device 20-1. The OVPN terminating device 30 retrieves the

vacancy in the converters 33 and 34 according to the received L1 type information so as

to register the IP address, VPNID, and the L1 type information into the database 39 if it

is possible to contain the L1 type information (step 22).

Here, the registering section 29 can not only obtain the L1 type information of

20   the user's device 20-1 from the user's device 20-1, but also obtain the L1 type

information from the signal determining section 8 shown in FIG 56. That is, the base

point device 23 is provided with a plurality of error detecting sections 7-1 to 7-3 and a

signal determining section 8. The error detecting sections 7-1 to 7-3 perform

calculation simulation processing's for a particular signal format respectively. Such a

25   calculation simulation processing's are designed so as to generate an error message to

signal format except a particular kind of signal format. The signal determining section

8 monitors the result in the calculation simulation processing's in the error detecting

sections 7-1 to 7-3. The inputted signal format type is specified by monitoring an

occurrence of error in the error detecting sections 7-1 to 7-3. Such a determined result

5   is notified to the registering section 29 so as to be transmitted to the OVPN terminating

device 30. In such a case, it is necessary for the user's device 20-1 to transmit the test

signal to the data line until the signal determining section 8 obtains the determined result.

Here, for other method for determining the signal format type, there is a

following method. In this method, inputted signals are inputted into the converters 33

10   and 34 by the optical switch 32 so as to monitor an occurrence of error. If any converter

33 or 34 in which an error does not occur is found, it is possible to determine that the

signal format which is handled in such a converter is the signal format of the inputted

signal.

Furthermore, as shown in FIG. 57, the base point device 23 is provided with a

15   retuning controlling device and an optical switch 91 which separates the user's device

20-1 and the OVPN and returns the test beam which is transmitted from the OVPN back

to the OVPN.

Also, in FIG. 52, the OVPN terminating device 30 is provided with the

converters 33 and 34, and the OVPN terminating device 30. However, it is possible to

20   dispose a collective converting device which is provided with an optical switch

controlling device 131 and an optical switch 132 for realizing a function of the converters

33 and 34 in a plurality of OVPN terminating devices 30-1 and 30-2 commonly as shown

in FIG. 58.

Here, in a case in which a plurality of collective converting devices are disposed,

25   a collective converting device which is disposed in a shortest path to the OVPN

terminating device is selected. In such a case, if the collective converting device which is disposed in the shortest path to the OVPN terminating device is occupied, the next shortest collective converting device is selected.

Twenty-sixth Embodiment

5   A twenty-sixth embodiment is explained with reference to FIG. 59. FIG. 59 is a view for explaining a structure in the twenty-sixth embodiment.

The base point device 23 in the twenty-sixth embodiment is inserted among the OVPN and the user's devices 20-1, 21-1, 20-2, and 21-2. As far as the user's devices 20-1 and 21-1 are concerned, the base point device 23 is provided with an optical

10   multiplexer 135 which multiplies a plurality of optical wavelength signals which are used in the user's devices 20-1 and 21-1 so as to transmit to the OVPN and a demultiplexer 133 which divides the optical wavelength signals which arrive from the OVPN so as to transmit to the user's devices 20-1 and 21-1. Thus, the base point device 23 notifies an information regarding the wavelength information and regarding that the wavelength is

15   multiplied regarding the optical multiplexer 135 and the optical demultiplexer 133 respectively via the control line.

Also, the OVPN terminating device 30 in the twenty-sixth embodiment is provided with an optical multiplexer 53 which contains the user's devices 20-1 and 21-1 via the base point device 23 so as to multiply a plurality of the optical wavelength signals

20   which arrive from the OVPN and transmit to the base point device 23 and an optical demultiplexer 152 which separates the optical wavelength multiplied signal which arrives from the base point device 23. The optical switch controlling device 31 transmits the optical wavelength signal which is demultiplexed by the optical demultiplexer to a predetermined path according to the information which is notified by the base point

25   device 23.

Here, the base point device is disposed in the user's device. However, it is possible to realize the same effect of the present invention even if the base point device is disposed in the network; therefore, the present invention does not depend on where the base point device is disposed. Thus, any disposition of the base point device can be

5 accepted in the present invention.

Twenty-seventh Embodiment

A twenty-seventh embodiment is explained with reference to FIG. 60. FIG. 60 is a block diagram for an OVPN terminating device in the twenty-seventh embodiment.

As shown in FIG. 60, the base point device 23 in the twenty-seventh

10 embodiment is provided with a serial/parallel converter 155 which is inserted between the OVPN and the user's device 20-1 so as to convert a serial signal which is transmitted from the user's device 20-1 into a plurality of parallel signals and transmit a plurality of the parallel signals to the OVPN and convert a plurality of the parallel signals which arrive from the OVPN into serial signals so as to transmit the serial signals to the user's

15 device 20-1. Thus, an information which indicates that the serial signals are converted into the parallel signals and an information regarding a topology of the parallel signals are notified to the OVPN.

The OVPN terminating device 30 in the twenty-seventh embodiment contains the user's device 20-1 via the base point device 23 so as to input the parallel signals

20 which are divided from a series of the serial signals into a plurality of converters 33 or 34 which correspond to the same first signal format according to the information which is notified from the base point device 23.

Twenty-eighth Embodiment

A twenty-eighth embodiment is explained with reference to FIG. 61. FIG. 61 is

25 a block diagram for the base point device 23 and the OVPN terminating device 30 in the

twenty-eighth embodiment.

As shown in FIG. 61, the base point device 23 in the twenty-eighth embodiment
is provided with a serial/parallel converter 155 which is inserted between the OVPN and
the user's device 20-1 and an optical multiplexer/demultiplexer 137. The serial/parallel

5   converter 155 multiplies the wavelength of the parallel signal which is obtained by
converting the serial signal which is transmitted from the user's device 20-1 so as to be
transmitted to the OVPN and separates the wavelength multiplication signal which
arrives from the OVPN into parallel signals and convert the parallel signals into the serial
signals so as to be transmitted to the user's device 20-1.   The OVPN is notified of an

10   information that the serial signal is converted into the parallel signal, an information
regarding a topology of the parallel signal, and an information that the wavelength of the
parallel signal is multiplied so as to be transmitted.

The OVPN terminating device in the twenty-eighth embodiment is provided
with an optical multiplexer/demultiplexer 127 which contains the user's device 20-1 via

15   the base point device 23.   The optical multiplexer/demultiplexer 127 multiplies the
parallel signal which arrives from the OVPN to be transmitted to the base point device 23
and separates the optical wavelength multiplication signal which arrives from the base
point device 23 so as to transmit to the OVPN.   The parallel signal which is separated
from the wavelength multiplication signal according to the information which is notified

20   by the base point device 23 is inputted into a plurality of converters 33 or 34 respectively
which corresponds to the first signal format.

Here, the optical signals which are inputted into the optical
multiplexer/demultiplexers 137 and 127 from the serial/parallel converter 155 an the
optical switch 32 for multiplying the wavelength between the optical

25   multiplexer/demultiplexers 137 and 127 are converted into wavelengths which are

different from each other.   The optical signals which are outputted from the optical

multiplexer/demultiplexers 137 and 127 to the serial/parallel converters 155 and the

optical switch 32 are reverted to the previous condition of wavelength under which the

optical signal is inputted from the serial/parallel converter 155 and the optical switch 32

.5   to the optical multiplexer/demultiplexers 137 and 127 respectively

Twenty-ninth Embodiment

A twenty-ninth embodiment is explained with reference to FIG. 62.   FIG. 62 is

a view for explaining a structure in a testing device in a base point device in the

twenty-ninth embodiment.   The testing device shown in FIG. 62 is provided with a

10   return controlling device 90 for separating the user's device 20-1 and the OVPN and

returning the test beam which is transmitted from the OVPN back to the OVPN and an

optical switch disposed in the base point device.

Thirtieth Embodiment

A thirtieth embodiment is explained with reference to FIG. 63.   FIG. 63 is a

15   block diagram for an OVPN terminating device in the thirtieth embodiment.   The

OVPN terminating device 30 in the thirtieth embodiment is provided with converters 33

and 34.   At least a part of converter 34 contains an optical multiplexer/demultiplexer

145 which converts a serial signals according to a serial first signal format which is

directed to the OVPN from the user's device into a signal according to a plurality of the

20   parallel second signal formats in the OVPN and converts a plurality of parallel signals

according to the second signal format which is directed from the OVPN to the user's

device into a serial signals according to the serial first signal format alternately.

By doing this, it is possible to handle a case in which a transmission speed

outside of the OVPN is faster than the transmission speed in the OVPN.   In an example

25   shown in FIG. 63, the transmission speed outside of the OVPN is 10 Gbit/s, and the

transmission speed in the OVPN is 2.5 Gbit/s.   It is still possible to handle such a case

because it is possible to convert the serial signals having 10 Gbit/s of transmission speed

and parallel signals in four lines having 2.5 Gbit/s of transmission speed alternately by

the optical multiplexer/demultiplexer 145.   It is possible to handle a speed conversion

5   by employing a structure shown in FIG. 63 in the collective converting device 100 with

combining the converters 33 or 34 in the collective converting device 100 shown in FIG.

10 and a optical multiplexer/demultiplexer 145 which is shown in FIG. 63.

Thirty-first Embodiment

A thirty-first embodiment is explained with reference to FIGS. 64 to 66.   FIG.

10   64 is a view for a structure of an OVPN in the thirty-first embodiment.   FIG. 65 is a

block diagram for a base point device in the thirty-first embodiment.   FIG. 66 is a flow

chart for showing operations in the base point device in the thirty-first embodiment.

That is, the base point devices 23-1 to 23-3 are inserted among the OVPN

terminating device 30 and the user's devices 20-1 to 20-4.   In the thirty-first

15   embodiment, as shown in FIG. 65, the base point devices 23-1 to 23-3 are provided with

a database 139 which stores a group for the base point devices which relate to the same

VPNIDs, an error detecting section 134 for detecting an occurrence of an error in a

control channel or in a data channel, and a subsidiary process requesting section 140

which requests other base point devices in the same group that the processes be handled

20   with reference to the database 139 when the error detecting section 134 detects the

occurrence of the error

Here, a user service section 141 has a function for improving operability for the

user by containing the user's device.   This function does not relate to the present

invention directly.   As far as a function in the user service section 141 is concerned, the

25   OVPN has a control line in which a control channel is disposed and a data line in which a

data channel is disposed.   The user needs to connect the user's device to these two lines

respectively.   In such a case, it is possible for the user to omit a connecting operation by

transmitting the data by multiplying the control channel and the data channel by

connecting the user's device and the user service section 141 by a transmission path and

5   separating the control channel and the data channel into the control line and the data line

by the user service section 141.   Alternatively, the user needs to notify the signal format

which is used in the user's device to the OVPN terminating device.   In such a case, it is

possible to omit the operation for notifying the signal format by the user by detecting the

signal format which is used in the user's device automatically by the user service section

10   141 and notifying the detected signal format to the OVPN terminating device in place of

the user.

Next, operations in the base point device in the thirty-first embodiment are

explained with reference to FIGS. 64 to 66.   FIG 66 is a flow chart for explaining

operations in the base point device in the thirty-first embodiment.   Explanation is made

15   with reference to the base point device 23-1 and the user's device 20-1 shown in FIG 64.

When an error detecting section 134 detects an occurrence of an error in the control

channel or the data channel caused in the base point device (step 23), an indication that

the error detecting section 134 detects an occurrence of an error in the control channel or

the data channel caused in the base point device to the subsidiary process requesting

20   section 140.   The subsidiary process requesting section 140 which is notified of that the

error occurs in the control channel retrieves whether or not there is other base point

device other than the VPNID (step 25).   In an example shown in FIG 64, the base point

device 23-2 has a same VPNID "a"; thus, the base point device 23-1 requests the base

point device 23-2 perform the subsidiary processing operation (step 26).   The base point

25   device 23-2 performs the subsidiary service for the user's device 20-1 in place of the base

point device 23-1 accordingly. If other base point device which has the same VPNID as that in the base point device 23-1 cannot be found, the base point device 23-2 emits an alarm to the user's device 20-1 (step 27). Thus, an error in the control channel or the data channel is notified.

5   Here, the user service section 141 has a function for performing the subsidiary processing operation after receiving a subsidiary processing request from the other base point device.

Here, in the OVPN, it is supposed that a node which detects an occurrence of an error transmits an error notification publication packet. The error detecting section 134

10   detects an occurrence of an error by receiving the error notification publication packet. Also, when the occurrence of an error in the base point device is detected, the error detecting section 134 transmits the error notification publication packet to the other node. An alarm for the user is converted to a signal format which is used in the user's device which is contained in the base point device so as to be transmitted to the user.

15   Thirty-second Embodiment

A thirty-second embodiment is explained with reference to FIG. 67. FIG. 67 is a view for showing a part a structure of the OVPN in the thirty-second embodiment. Here, a structure of the base point device in the present embodiment is the same as the structure shown of the thirty-first embodiment shown in FIG. 65. In the thirty-second

20   embodiment, the base point devices 23-1 and 23-3 are connected to a plurality of OVPN terminating devices 30-1 and 30-2 commonly respectively. Here, explanation is made for the base point device 23-1, the OVPN terminating devices 30-1 and 30-2. As shown in FIG. 67, the base point device 23-1 in the thirty-second embodiment is connected to a plurality of OVPN terminating devices 23-1 and 30-2. Also, as shown in FIG. 65, the

25   base point device 23-1 in the thirty-second embodiment is provided with a database 139

for storing a groups for the OVPN terminating device 30-1 and 30-2 which relate to the same VPNID, an error detecting section 134 for detecting an occurrence of an error in the control channel and the data channel, and the subsidiary process requesting section 140 which requests other OVPN terminating device 30-2 in the same group perform the

5   subsidiary processing operation with reference to the database 139 in place of the OVPN terminating device 30-1 in which an error occurs in the control channel when the error detecting section 134 detects an occurrence of an error in the control channel or the data channel caused in the OVPN terminating device 30-1.

Next, operations in the base point device in the thirty-second embodiment is

10   explained with reference to FIG. 68.   FIG. 68 is a flow chart for explaining operations in the base point device in the thirty-second embodiment.   Here, explanation is made for the base point device 23-1, the OVPN terminating devices 30-1 and 30-2 shown in FIG. 67.   When an error detecting section 134 detects an occurrence of an error in the control channel or the data channel caused in the base point device (step 23), an indication that

15   the error detecting section 134 detects an occurrence of an error in the control channel or the data channel caused in the base point device to the subsidiary process requesting section 140.   The subsidiary process requesting section 140 which is notified of that the error occurs in the control channel retrieves the database 139 (step 24) for whether or not there is other base point device other than the VPNID (step 25).   In an example shown

20   in FIG. 67, the OVPN terminating device 30-2 has a same VPNID "a"; thus, the base point device 23-1 requests the OVPN terminating device 30-2 perform the subsidiary processing operation (step 26).   The OVPN terminating device 30-2 performs the subsidiary service for the base point device 23-1 in place of the OVPN terminating device 30-1 accordingly.   If other OVPN terminating device which has the same VPNID

25   as that in the OVPN terminating device 30-1 cannot be found, the OVPN terminating

device 30-2 emits an alarm to the user's device 20-1 (step 27). Thus, an error in the control channel or the data channel is notified.

Here, when the OVPN terminating device has a function for performing the subsidiary processing operation accordingly after receiving the subsidiary processing request from the base point device.

Thirty-third Embodiment

A thirty-third embodiment is explained with reference to FIG. 69. FIG. 69 is a block diagram for showing a technical feature of an OVPN terminating device in the thirty-third embodiment. A block structure shown in FIG. 69 is disposed in a part of an optical switch controlling device 31 in the OVPN terminating device 30 shown in FIG. 64. As shown in FIG. 69, the OVPN terminating device 30 in the thirty-third embodiment is provided with a database 148 for storing a group for other OVPN terminating device which relates to a same VPNID, an error detecting section 35 for detecting an occurrence of an error in the control channel and the data channel, and the subsidiary process requesting section 36 which requests other OVPN terminating device 30-2 in the same group perform the subsidiary processing operation with reference to the database 148 in place of the OVPN terminating device 30-1 in which an error occurs in the control channel when the error detecting section 35 detects an occurrence of an error.

Operations in the thirty-third embodiment is the same as the operations in the third-second embodiment shown in FIG. 68. Here, the occurrence of an error is detected in the base point device in the thirty-second embodiment. In contrast, the occurrence of the error is detected in the OVPN terminating device in the thirty-third embodiment.

As explained above, in the OVPN, it is supposed that a node which detects an occurrence of an error transmits an error notification publication packet. The error detecting section 35 detects an occurrence of an error by receiving the error notification

publication packet. Also, when the occurrence of an error in the OVPN terminating

device is detected, the error detecting section 35 transmits the error notification

publication packet to the other node.

Thirty-fourth Embodiment

5   A thirty-fourth embodiment is explained with reference to FIG. 70. FIG. 70 is a

view for explaining a structure of a testing device in the base point device in the

thirty-fourth embodiment. The testing device shown in FIG. 70 is disposed in the base

point device. The testing device shown in FIG. 70 is provided with a return controlling

device 90 for separating the user's device 20-1 and the OVPN and returning a test beam

10   which is transmitted from the OVPN and an optical switch 91.

As explained above, according to the present invention, it is possible to handle a

request by the user for changing the setting for the signal format which is employed in

the user's device quickly. Also, it is possible to realize an OVPN which can perform a

process for a calling connection request from the user efficiently and improve an

15   operability for the user.

Also, it is possible to omit a signaling processes which are invalid during an

operation on the OVPN.

Also, it is possible to realize an OVPN in which it is possible to improve an

operability for setting up processes for the OVPN for the user.

20   Also, it is possible to realize an OVPN in which it is possible to use a

transmission path in the OVPN efficiently.

Also, it is possible to realize an OVPN in which it is possible to transmit the

signals in the OVPN efficiently by using a multiplying operation. Furthermore, it is

possible to realize an OVPN in which it is possible to set a length of signal desirably by

25   dividing and transmitting a long signal.

Also, it is possible to realize an OVPN in which it is possible to connect the user's device to the OVPN efficiently and realize an operability for the user.   +++

Also, it is possible to realize an OVPN in which it is possible to use a transmission path efficiently.

5   Also, it is possible to realize a reliable OVPN.